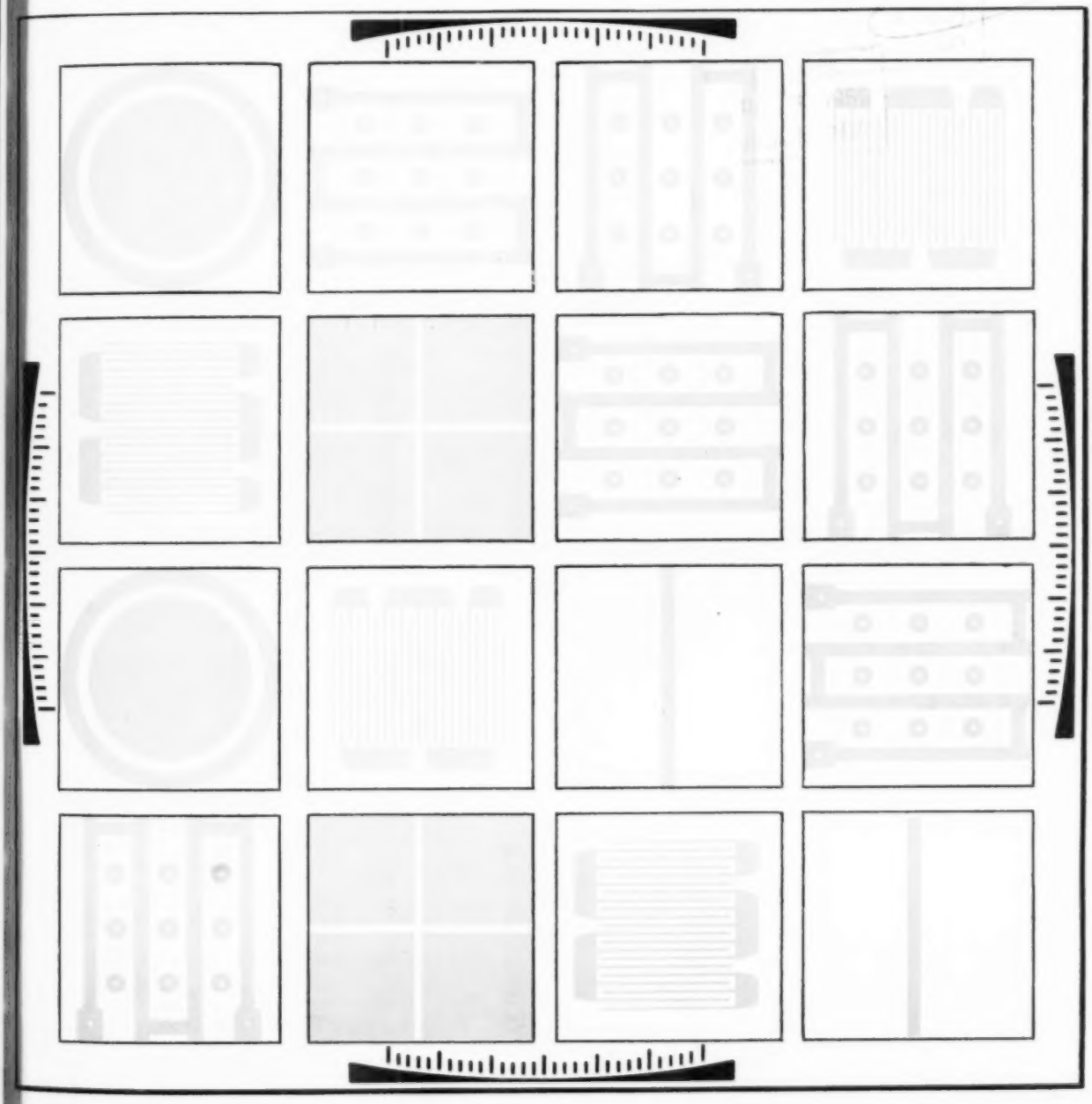
ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING

JULY, 1959

Applied Science Dept.



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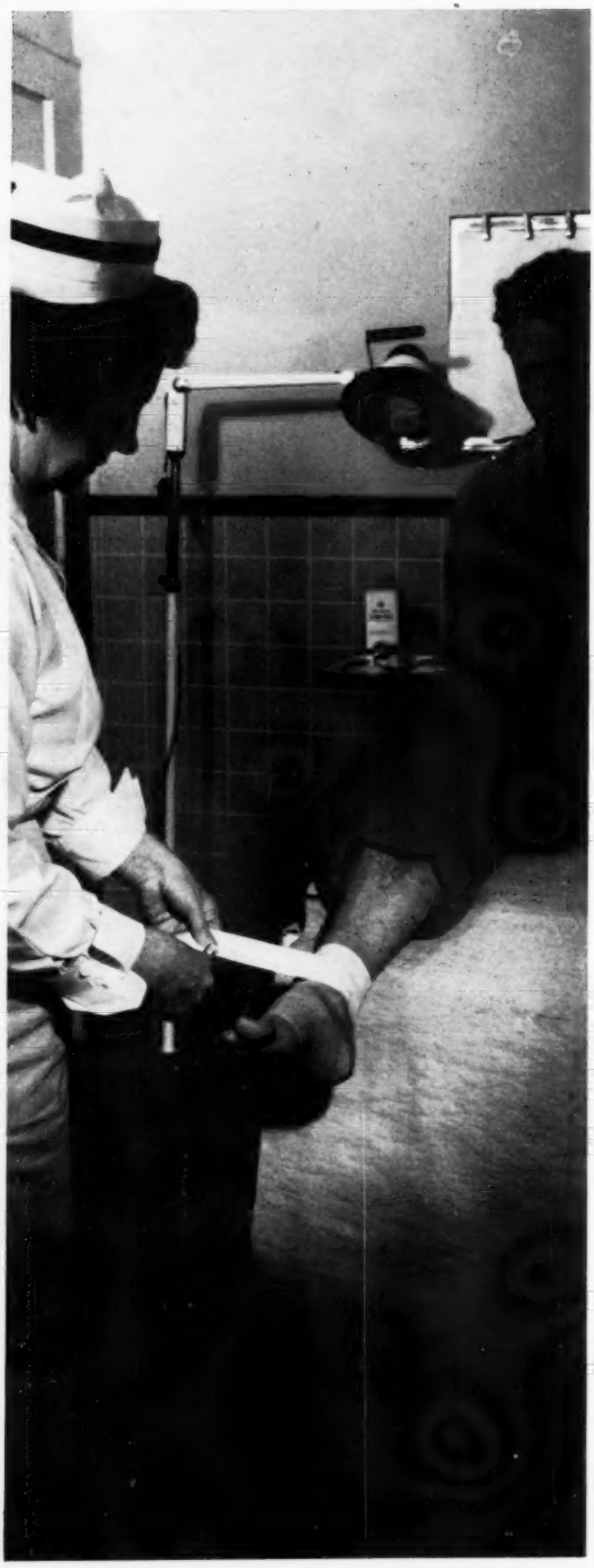

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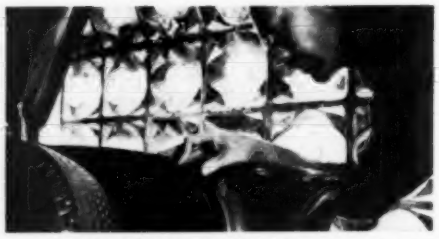

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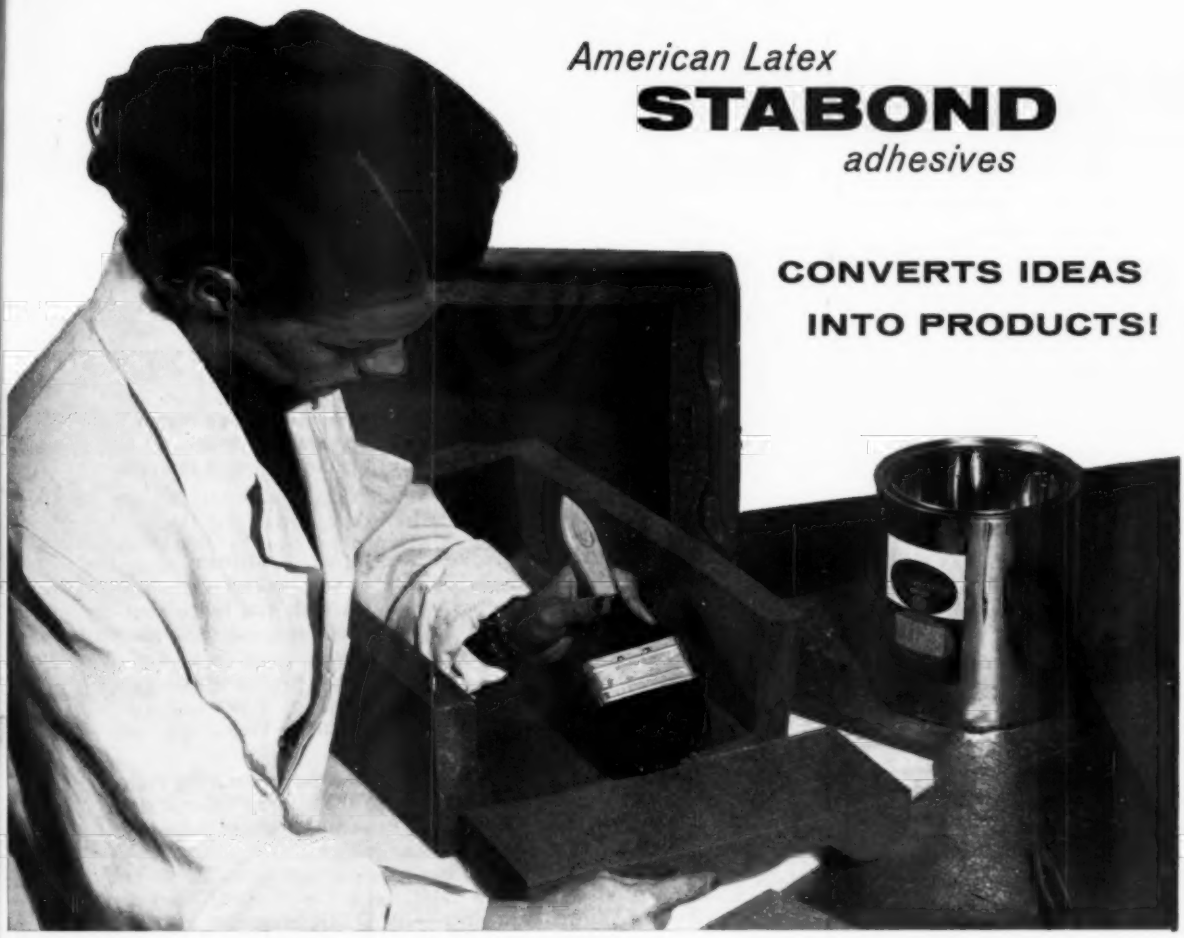

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ADHESIVES AGE

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This month's cover is a reproduction of test patterns for evaluating metal-clad laminates used in printed wiring production. The tests cover the base material, the adhesive bonding and the cladding foil. The quality etch wedge calibrations help determine the etch thickness. For more information see the article beginning on page 18.

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PP PALMERTON PUBLISHING CO., INC.

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This new "minimum glue line" neoprene adhesive for bonding latex and urethane foams meets all the requirements for efficient production and quality of finished product. Strength tests (photo above) result in the rupture of the foam . . . not the adhesive bond . . . despite the use of drastically thinner glue lines. Result: greater yield per gallon of adhesive, stronger bonds for the finished product.

Applied by brush, spray or roller, this flexible neoprene adhesive can be used for bonding latex or urethane foams to themselves *or to each other* . . . regardless of shape, density or cell structure. A single component, it needs no mixing . . . can be used directly from the container. Smooth application characteristics eliminate need for skilled personnel . . . yield lower labor costs.

In addition, this neoprene adhesive offers quick grab, speeds production time, has fast tack loss, and remains soft around seam areas. Cemented articles show no unsightly or uncomfortable dimples. Once joined they retain proper dimensions.

Why don't you investigate the possibilities of adhesives based on Du Pont neoprene? They can be compounded to join a wide range of rigid or flexible materials. For more details, contact your nearest adhesives supplier. His compounding "know-how" will insure you the right type of neoprene adhesive to fit your particular requirements. A list of suppliers is available from E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department AA-7, Wilmington 98, Delaware.

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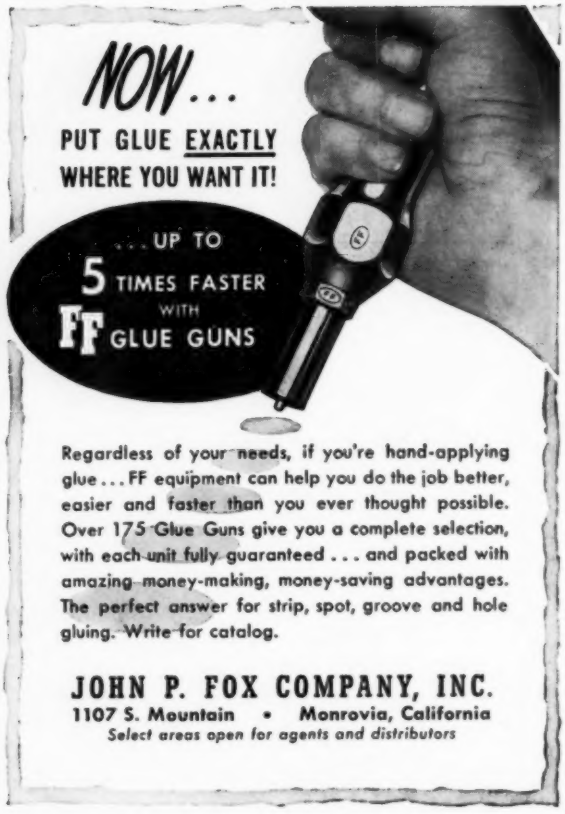
EDITORIAL

Designing With Adhesives

The 1959 Design Engineering Show held in the latter part of May in Philadelphia, Penna., emphasized a point we have been trying to make in these columns—there are an infinite number of areas in which adhesives play an important role. Some twenty prime adhesives manufacturers actively participated in the show. Above and beyond these companies, however, adhesives were featured in displays set up by many, many manufacturers. In the area of finishes and coatings, for example, adhesives, sealants and coatings produced by many different concerns were utilized in the production of new and interesting end-products. Among exhibitors of non-metallic materials were found many displays involving products in which adhesives play a vital part. Displays of shapes and forms also pointed up the many uses to which adhesives are now being put. Electrical and electronic components formed another category in which adhesives played a prominent role. There was scarcely a display or a group of displays in which one could not detect some new and interesting adhesive application.

All this has led us to a conclusion—an "educated guess" if you will—that the market for adhesives is apparently larger than many of us have previously estimated. It is frequently quoted that this and that industry has sales of $6 billion or $4.5 billion, but no one is now able to state with certainty the exact dollar volume involved in adhesives industry sales. For some reason, many persons actively engaged in the adhesives industry have been almost loathe to admit that the industry is itself a major entity. By any yardstick, the adhesives industry is a big industry. In figures published by the government, however, as in the Census of Manufactures, the adhesives industry is nowhere to be found. Surely, adhesives are rather perfunctorily mentioned, but nowhere does the adhesives industry get the attention that industries with less financial stature have attained. One explanation, of course, lies in the fact that the adhesives industry as an industry is relatively new. Secondly, much of the confusion lies in the fact that adhesives, as component parts of many end-products, are frequently lumped with the end-products rather than identified by themselves.

Only one point will be made here. The adhesives industry is not the small apple on the large tree. Rather, the industry is a large and complex entity with branches, shoots and buds cropping up every day. It is an industry with potentials for growth far greater than many other industries enjoy. We think these are facts worth noting.



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CONSULTANT'S CORNER

By Dr. Irving Skeist

The Versatile Vinyls

To the adhesives user, "vinyl" most commonly refers to a latex based on vinyl acetate resins. To the molecular engineer, vinyls may also be polyvinyl chloride upholstery sheeting, polyethylene pipe, latex paint from acrylate esters, fibers from acrylonitrile, rubbers from butadiene and styrene. The vinyls are the biggest and most versatile group of building blocks with which an adhesive resin can be put together.

A vinyl resin begins life as a *monomer*—a small molecule with an urge to get together with other monomers. Hundreds or thousands of vinyl monomer molecules may combine to form a single big *polymer* molecule. Monomers are usually odorous, volatile liquids; polymers are solid materials or viscous liquids with no odor.

There are more combinations of vinyls than poker hands. A dozen monomers have become basic organic chemicals, and scores of others are also available. If no monomer by itself gives a *homopolymer* having the properties you are seeking, then two or more monomers can be combined in a *copolymer* which may be effective. Sometimes the copolymers have properties intermediate between those of the corresponding homopolymers; but often there is an extra bonus of solubility, tack, flexibility, or better adhesion.

Some pairs of monomers team up readily, while others cannot be made to work together. Vinyl acetate and styrene is an example of a poor match. Each of these by itself polymerizes rapidly, but styrene tends to slow down vinyl acetate to such an extent that the combination is useless. It is part of the polymer chemist's job to know which groupings are helpful and which are antagonistic.

In making a vinyl resin, there are several procedures to choose from:

1) *Bulk.* The monomers and a pinch of catalyst form a clear liquid mixture which is heated until it solidifies. The catalyst is added for speed. This is the procedure used by many companies to make polystyrene and other plastic molding powders. Because of its simplicity, it is often the first technique used by the lab man in trying out a new monomer or combination of monomers. In the volume production of an adhesives base, however, other methods are usually preferred for ease of handling and better properties.

2) *Solution.* The monomers and catalyst are dissolved in a solvent, then heated to bring about polymerization. As the monomers combine, the liquid thickens to a viscous *dope*. When this is spread on the surface being coated or bonded, the solvent evaporates.

An important application of solution polymers is the preparation of *continuous* layers of resin. For example, a moisture-proof laminate is obtained through the use of a vinyl chloride copolymer solution. If the same copolymer were employed in the form of an aqueous dispersion,

the laminate layer might be full of pinholes which would permit the transmission of moisture vapor.

The solution technique is objectionable because of the cost of the solvent, which evaporates when the dope is applied to the substrate. Also, some solvents are toxic—notoriously benzene, methanol, and carbon tetrachloride—and most organic solvents are inflammable, with the notable exception of the chlorinated solvents and a few others.

3) *Emulsion* or *latex*. This is the preferred technique in most adhesives applications of vinyls. The emulsion polymer may be tricky to manufacture, but is easy to apply. Water is cheap, non-inflammable, non-toxic.

Monomers, water, emulsifier, protective colloid, catalyst, buffers and other ingredients may be included in the polymerizing mixture. The formulator has many variables to play with, in addition to composition: solids content, viscosity, particle size, pH (acidity or alkalinity), etc.

4) *Suspension*. This technique also uses water, plus a less efficient dispersing system that results in larger particles of resin than those found in a latex. If the suspension is stabilized with a protective colloid such as polyvinyl alcohol, it will be quite viscous. This can be an advantage in preventing excessive penetration into a porous substrate such as paper or wood.

Let us look at some of the vinyl type monomers from which adhesives can be constructed:

Vinyl acetate is a fruity liquid that polymerizes to a soft resin. Its emulsion and suspension polymers are especially useful in the bonding of paper and wood. The molecular architect can use vinyl acetate by itself, or he can combine it with other monomers—maleates, acrylates, etc.—for softness and tack.

A small amount of acid monomer such as crotonic acid, acrylic acid or maleic anhydride will improve its adhesion to leather, glass or metal, and will also make it alkali-soluble—an important consideration for bookbinding adhesives since it facilitates recovery of the broke.

When polyvinyl acetate is partially hydrolyzed, the result is polyvinyl alcohol, one of the most effective of the water-soluble adhesives. From polyvinyl alcohol comes polyvinyl butyral, a superior resin for laminating glass.

Dienes and *olefines* give us most of our rubbery adhesives. Natural rubber itself is a variety of polyisoprene. The most common synthetic rubber for tires is a copolymer of butadiene and styrene; but the synthetic rubber most widely used for adhesives is a copolymer of butadiene and acrylonitrile. Neoprene (polychloroprene), polyisobutylene, and butyl rubber (isobutylene with a dash of isoprene) appear often in the adhesive maker's recipe book. New techniques of polymerization have focused much attention on the dienes and olefines, and the adhesives user should begin to benefit soon.

As the *acrylate esters* come down in price, there will be more room for them in critical latex bonding applications.

Unsaturated aldehydes have not yet had a chance to show what they can do. They are hydrophilic, have affinity for cotton and rayon, can be cross-linked. *Vinyl pyrrolidone* polymers are attractive for compatibility, solubility, adhesion. *Amino* and other basic polymers deserve more attention—they should bond exceedingly well to some adherends.

To the imaginative researcher, vinyl polymers continue to offer challenge and promise.

Dr. Skeist is associated with Skeist & Schwarz Laboratories, Inc., 89 Lincoln Park, Newark 2, N.J. He is the author of the recently published book, "Epoxy Resins."

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AND ADHESIVE PRODUCTS

Particle Board Bondant

Specially designed for particle board manufacturers using multi-platen presses, Auto-Set 31 eliminates the need for catalyst mixing. The product is a self-curing liquid urea resin. Laboratory tests and field production runs showed that the product provides up to 25 per cent greater internal bond while reducing the press cycle time up to 20 per cent, the manufacturer points out. In addition, it minimizes surface precure; reduces formaldehyde fumes before, during and after pressing; and allows for uniformly consistent particle board manufacturing operations. The molecular size of the resin polymer is adjusted to give a maximum coverage and minimum penetration. *Borden Chemical Co.* **P-131**

Adhesive Labels

Golden Perma-Grip Labels are coated with a newly developed perma-grip adhesive that is said to provide from 100 to 300 per cent stronger sticking power than previous types. They can be applied to metal, glass, wood, plastic, rubber-coated materials, and even rough or curved surfaces. They will not curl, peel, or scuff unless scraped with a sharp object, states the manufacturer. A specially treated backing paper for these self-adhesive labels allows them to be removed effortlessly for swift application at temperatures ranging from minus 70°F. to 350°F. *Avery Label Co.* **P-132**

Neoprene Sealer

A one-part elastomeric formulation, Stay-Tite Neoprene Sealing Compound was developed for use in sealing joints where high adhesive and cohesive strength are necessary, states the manufacturer. Ready to use from the container, it is said to have good adhesion to all building materials. Application is by caulking gun or knife. Added features include uniform consistency, non-tacky surface, and easy clean-up. Claimed adhesion per square inch is 200 pounds; elongation, 150 per cent; life expectancy, 15 years. *Stay-Tite Products Co., Inc.* **P-133**

Waterproof Primer

Wall areas can be treated with CTA Waterproof Primer prior to the application of water dispersed ceramic tile adhesives. This mastic type primer will waterproof base surface areas subject to moisture such as shower stalls or tub recesses. It can be used to prime gypsum wallboard, finish coat plaster, painted plaster, concrete, unpainted plywood and even old ceramic or glass tile over

which new installations are to be made. Said to have excellent handling properties, the primer can be applied with the same notched trowel used to apply the adhesive. The flat edge of the trowel is used to apply a thin-skin coat and a putty knife is employed to cover the edges of all openings around pipes, etc. A drying time of 15 to 30 minutes should be allowed before the actual adhesive application. *Adhesives, Coatings & Sealers Division, Minnesota Mining & Mfg. Co.* **P-134**

Polystyrene Bondants

Two new adhesives are announced for specialized use in bonding polystyrene: A-827-B for use with foamed-in-place polystyrene and R-1083-T for bonding prefoamed polystyrene to itself, polystyrene sheet, steel, aluminum, transite, formica and other materials.

A-827-B is an opaque cream-colored, medium viscosity, solvent type solution adhesive. Based on synthetic rubber and using a methyl ethyl ketone solvent, it is supplied in a 30.5 total solids form. The most common method of application is by brush, however the solution can also be applied by spray, dip or roller. After application, it will air dry by forming a rigid bond which possesses some residual tack. It will not stain materials to be joined, and produces a bond that has excellent heat resistance up to 240°F.

R-1083-T is a pink-colored, medium viscosity, solvent type solution. Based on synthetic rubber and using an unleaded gasoline solvent, it is supplied in a 30 per cent total solids form. Brushed or sprayed on, the adhesive film when dry is tasteless and odorless. It will not result in any noticeable stress crazing of polystyrene. Bonds withstand repeated simulated weathering cycles involving 160° to −40°F., plus water immersion and salt spray environment. *B. F. Goodrich Industrial Products Co.* **P-135**

Epoxy Resins

As adhesives, Maraset 617 epoxy resin formulations have a sheer strength on aluminum to aluminum bonds of 1380 psi at 400°F. Resin 617-A is aluminum-filled and resin 617-C is clear. Both have low viscosity which can be maintained at room temperature for as long as 30 minutes after mixture with a hardener. Both formulations are resistant to operating temperature as high as 500°F. Their heat distortion point is 424°F. At higher temperatures, they retain elasticity rather than exhibiting a tendency to break such as is characteristic of epoxy compounds with twice the maximum deformation, states the manufacturer. Maximum deformation is .01 in./in., and is partially recoverable. *Marblette Corp.* **P-136**

Potting Compound

Made without solvents or thinners, Helix Potting Compound P-460, is a 100 per cent epoxy resin. It is poured cold and has a cure time of about two hours at 70° to 80°F. It is said to have outstanding adhesion to metal, wiring, etc. P-460 cures hard, yet is sufficiently flexible to withstand hot-cold cycling without cracking. It is chemically inert to solvents, acids and alkalis. *Carl H. Biggs Co., Inc.* **P-137**

FOR MORE INFORMATION on the new products reviewed here, use the Reader's Service Card which appears elsewhere in this issue.

Two-Sided Tape

Kleen-Stik two-sided tape is a thin, strong, fiber-filled strip of adhesive on a carrier tape backing paper. The adhesive is applied by pressing the exposed surface on the article to be mounted or posted. The carrier backing paper is then peeled off, exposing the second adhesive surface. The tape's ⅛-inch finger-lift edge, an ungummed margin on the carrier paper, allows easy release of the backing. The adhesive is available in ½-inch, ¾-inch, one-inch, one-and-a-half-inch and two-inch stock widths. Larger widths up to 54 inches are available. *Kleen-Stik Products, Inc.* P-138

Protective Coating

An epoxy-based combination skid-proofing and protective coating, PG-1013 is designed to combat excessive wear and corrosion of concrete floors. It is said to provide excellent resistance to wear, water, detergents, alkalis, mild acids, oil, grease, industrial fumes and many other common reagents. PG-1013 welds itself to concrete surfaces and seals cracks. It will also bond to other types of masonry, to steel and to many other building materials. The product consists of two components, one including the thermosetting resin base and the other containing the reactor. Mixing equal volumes of the two initiates the curing cycle. The only surface preparation required is the removal of dirt, grease, loose particles or previous coatings that may flake off. *Permagile Corp. of America.* P-139

Vinyl Cement

Soft plastic products can be easily repaired with Carter's Vinyl Cement. The adhesive bonds vinyl to vinyl and dries quickly forming a flexible weld. Typical applications include mending seat covers, wading pools, children's toys, etc. *Carter's Ink Co.* P-140

Liquid Polyester

Certain end use characteristics of ATLAC L-382-13 approach those of epoxies. Based on a bisphenol derivative reacted with fumaric or maleic anhydride, this liquid polyester is said to offer special advantages in applications where elevated temperatures or corrosion cause physical, chemical or electrical failure in normal polyesters. Features include superior resistance to water, acids and alkalis. As a result of a higher heat distortion temperature, 285°F., than conventional polyesters, parts will retain a greater proportion of initial strength at elevated temperatures. Lack of styrene after-odor recommends this material when parts are used for food or consumer items. *Atlas Powder Co.* P-141

Silicone Bonding Aid

An amino-silane, Z-6020 reacts with both organic and inorganic materials to unite them in a strong, resistant bond. Applications include the addition of the silane to glass-fiber insulation in order to enhance resiliency and resistance to moisture and the epoxy resins used in resin-glass laminates. In water solutions, hydroxyl groups form on the silicone atom and attach themselves to materials such as glass, metal or minerals. *Dow Corning Corp.* P-142

Tile Adhesive

Brushed, sprayed, or rolled on, Formica Wall Tile Adhesive is said to have excellent bond and initial grab strength. Nonflammable and essentially odorless, it is milky-aqua as it comes from the container and dries to a transparent green when ready for application. A quart will cover 70 square feet, or 100 tiles; a gallon covers 280 square feet or 400 tiles; and a five-gallon container covers 1400 square feet, or 2000 tiles. *Formica Corp.* P-143

Wood Adhesive

Practically 100 per cent wood failure on all types of wood is said to be obtainable with Permabond 665. This wood adhesive develops bonds of superior strength and offers solvent and heat resistance not obtainable with conventional polyvinyl acetate white glues, states the manufacturer. It has wet-tack similar to animal glues but requires no heating or processing. *Continental Chemical Corp.* P-144

Pipe Sealant

Designed to seal and permanently lubricate pipe joints, "Scotch" brand Pipe Sealant Tape, Number 547, is an unfused film tape available in three and four mil calipers. It is made with a Teflon TFE-fluorocarbon resin and can withstand processing temperatures from liquid-oxygen range through that of superheated steam, according to the manufacturer. Although actually non-adhesive, the tape is sufficiently cohesive to stick to its own glossy surface. Easy application eliminates the need for brushing dope solutions on pipe fittings. *Minnesota Mining & Mfg. Co.* P-145

Sealing Compound

Completely watertight, Formica Wall Tile Seam Finish is a flexible sealing compound for use between wall tiles and as a sealer around the tub itself. Made with an elastomeric material with water as the vehicle, the material is white and of a heavy paste consistency. The sealer is said to expand or contract with the tiles, maintaining a smooth, flowing surface across the wall. Successfully used as a marine caulking compound, the product has been adapted for use in residential bathrooms. A five-ounce tube—sufficient for a moderate installation—sells for approximately $1.50. *Formica Corp.* P-146

Printable Adhesive Tape

Messages can be printed on the adhesive side of Permacel 165 tape. Made of Mylar with nylon strand reinforcement, it features a high degree of transparency, high impact strength, extreme thinness and waterproofing qualities, states the manufacturer. It has almost complete recovery after elongation and is recommended in applications where constant tension is required. *Permacel.* P-147

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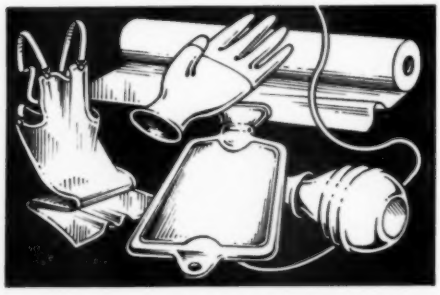

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capitol cues

CREDIT IS GOING TO GET A LOT TIGHTER in the months ahead. Up to now, despite the steady increases in interest rates, money has not been really scarce—that is, really hard to come by. But soon after the middle of the year you'll see a significant change. And before this trend turns around, you may well see the country's tightest credit situation since World War I.

Though the supply of money has been going up since February, the demand for loans has risen even faster. A number of the banks are now "loaned up." As a result, loan interest rates have risen from an average of 4.2% for borrowers of all sizes in February to 4.7% in May. Rates are near a 30-year high.

Here's what will tighten credit in coming months:

- Business investment is now on the rise and will probably be shooting up this Summer. Many firms are increasing their expansion plans. Consumer buying will expand rapidly, too.
- Public works programs of state and local government units will prompt sale of near-record amounts of municipal bonds.
- Credit policies of the Federal Reserve will be tightened to reduce the amounts of money available to banks for lending.
- Treasury financing of deficits will fall on banks as many companies put profits into expansion, not U.S. obligations.

Interest rates probably will go up another ½% before this cycle is over. Many borrowers will discover that lenders are screening more closely. Some will get less than their needs.

SOME RESERVATIONS ABOUT TODAY'S GOOD BUSINESS are now being expressed in Washington by officials and economists. Of course, they are well pleased about the strong upward surge that is under way; but they have some nagging questions as to what may be lying ahead. They are concerned over prospects in some lines that are doing well now, as well as about the credit outlook.

Though inventory building is exceeding forecasts, giving business a rosy hue, much stocking-up reflects fears of a steel strike. New housing starts are at near-record rates, but officials fear a growing shortage of mortgage money will soon begin to slow things down. Auto sales are doing well, but much of recent production has gone to dealers' stocks.

A slower rate of expansion later in the year wouldn't cause pessimism among analysts. It could stretch out the upturn; then current prosperity might extend to late '60, at least.

A NEW TONE IN STOCK MARKET SPECULATION, detected in the past month or two, is worrying officials in Washington. They fear what it can do to the business upturn for it has some of the flavor of 1929. Investors seem to be thinking of buying for a quick profit only, rather than investing for the long haul on the basis of reasonable earnings or a company's dividend prospects. Government agencies are doing what they can—going after those who break market rules, curbing credit, and issuing warnings to the public.

capitol cues (cont'd)

U.S. EXPORTS WILL INCREASE ABOUT 6% in the second half, according to government foreign-trade experts. This implies another plus for business because the lag in shipments abroad so far this year has been one of the few negative factors in the economic outlook. During the first quarter, exports dropped 6% from 1958's $16¼ billion to an annual rate of about $15¼ billion. In the second half, the experts see the rate getting back up to $16 billion.

One big factor in the exports turnaround will be a pick-up in sales of cotton. (A drop in fiber sales accounted for about half the total export decline of the first quarter.) Now, the Agriculture Department plans to lower the price of cotton in overseas markets to make it more competitive.

Other exports will do better, too—industrial machinery, mining, farm, and construction equipment, semi-finished manufactures, and grains; but these gains will be small. Shipments will rise to Europe, Cuba, and the Far East.

PROTECTIONISM IS ON THE RISE IN THE U.S. these days. Foreign trade experts point to recent actions curbing imports of wool, lead, zinc, and oil. Similar moves may come in electrical equipment, cobalt, dental drills, furs, leather, carpet wools, etc. Tighter curbs on these products are under study.

Here's what's behind the shift away from free trade:
- The unions, which formerly went all out for lower barriers, now are joining with industry in an attempt to save jobs.
- Southerners, once so concerned with foreign sales of cotton, tobacco, etc., now have industries they want to protect.
- The Common Market being set up by Europeans, it is feared, will mean a vastly increased flow of goods to this country.

THERE ARE GOOD OPPORTUNITIES IN MISSILE WORK for small and medium-sized firms, say federal procurement officials. And it's not only rockets, fuels, or very complex electronics that's involved in missile-buying. The various missile agencies also buy a lot of supporting products—abrasives, building materials, lumber, chemicals, paint, plumbing supplies, hardware of all types, drafting materials, etc., etc. The government has set up several programs to help smaller firms get a share of available subcontracts; work is specifically set aside by buying officials for small firms, exclusively.

How should a small business go about getting an order?
- Check your immediate area for prime contractors who can place subcontracts. Chambers of Commerce can give you help on this.
- Check U.S. publications for information on available work. Write the Small Business Administration, the armed services, and the Commerce Department to add your name for notification of bids, detailed specifications, and other pertinent facts.
- Contact regional offices of SBA. The agency has vital data on prime contractors, who to contact, and the products needed.

ADLAI STEVENSON IS STILL VERY MUCH A CONTENDER for the Democratic nomination in 1960. His name refuses to fade from talk of Party leaders. Political experts are struck by this fact over and over. Though Stevenson is a two-time loser, many in Washington still think he is the man to beat.

• A few months ago, we pointed out that the German Uhu-Glue, a particular kind of adhesive, can be found in almost every hardware store, five and ten cents store, and other related outlets all over the United States. In the meantime, we have received more information regarding the manufacturer of this adhesive and it is interesting to note that a tremendous building, located in Buehl in the province of Baden in West Germany, is devoted exclusively to the manufacture of this adhesive.

Uhu-Glue is exported from 80 countries. In Milan, Italy, there is a factory owned by the Uhu firm and in Austria, France, Belgium, Spain, Egypt, South Africa, Turkey, Mexico and Argentina, there are affiliated companies which manufacture the Uhu adhesive as licensees of the parent company. The United States and Canada are supplied by the Uhu Products Corp. in New York City. Daily output of the parent company in Germany amounts to 400,000 tubes.

• At a plenary session of the Moscow 8th Mendeleyev Congress on Chemistry, the director of the Soviet Plastics Institute, Akutin, reported on the development of the first installation to produce continuously grafted polymers. This installation is based on a mechanical-chemical method which makes it possible to break the molecules of polymers and combine them into new substances. The director expressed confidence that in the near future it would be possible to use such installations on a commercial scale.

• Synthetic resins are finding increased use in the production of molds in Germany, according to *Rubber Journal and International Plastics*. Many of these resins have been found to possess good mechanical properties, moisture and aging resistance, excellent adhesion on metals, and stability. Some advantages are quick and low cost production; unlimited capacity for copying; and wear-resistance. Care has to be exercised during production because of tension sensitivity, lower fatigue limit and temperature dependence.

• The corrosive effects of plastics on metals have been studied in Germany. Plastics employed in combination with metals should not have corrosive effects on the metals, particularly in damp or tropical climates, e.g., when used as insulation for telephone networks and electrical instruments. Various test methods have been developed and probable causes of corrosion suggested. The effect was first observed in hard paper and fabric, and later in other combinations. The actual cause of corrosion has not yet been fully explained, although it is believed to be the result of electrolytic action. With hard paper and all filled plastics, the filler undoubtedly plays a decisive part. Suitable means of impregnation may control corrosion to some degree. Research in this direction continues.

• Properties of films and other shaped bodies of polyethylene can be improved according to a patent which was recently granted to Deutsche Goldund Silver-Scheideanstalt vormals Roessler. This can be done by incorporating into the polyethylene one or more finely divided oxides of a metal or non-metal of groups 2, 3, or 4 of the Periodic Systems and then stretching the shaped polyethylene beyond its elastic limit. The oxides are obtained by reaction of a volatile compound of the metal or non-metal in the vapor or gaseous phase in the presence of an oxidizing and/or hydrolyzing gas. Aluminum oxide and silica may be used as the oxides.

• The United States Department of Commerce has compiled a special catalog which contains a listing of many books, brochures and pamphlets dealing with adhesives, which were published between the years of 1922 and 1956. This catalog enumerates many books, reports, press releases and other material dealing exclusively with adhesives. All facets of the adhesives industry and the application of adhesives are discussed in the various publications. The following excerpts will demonstrate the scope of this catalog:

Adhesives in Germany, (Kline) 1945, 13p. Summary of the composition and uses of the following adhesives: Cosavult. Polystal, seven different Cosals, Kaurit W. Kaurit MS-Pulver, Kaurit WHK-Pulver, Heat Hardener K-Pulver, Karlharter Blau Pulver or Weiss Pulver, Bu-Pulver (HK 986), cold-setting phenolic adhesive (P 500) and Cohesans. Cosavult is an adhesive based on natural latex. Polyurethane adhesives were made by the reaction of polyisocyanate with a polyhydroxy compound. Cosals were based on polyvinyl ethers, chiefly polyvinyl isobutyl ether. They were used chiefly in installing upholstery in motor cars, sealing cellophane and other foils, and in cementing materials to glass and metal. Cohesans were based on nitrocellulose and used for household and general purpose gluing.

Manufacture and Use of Some German Synthetic Adhesives and Raw Materials, (De Bruyne BOIS Final Report 456, Item 22, 1946, 67p. This is a report on German synthetic adhesives. A number of firms were investigated and their manufacturing methods described. Products discussed are: (1) P600 cold setting glue, made by reacting phenol, 30% formalin, and caustic soda; (2) "Pressal", fundamentally 30% melamine formaldehyde resin and 70% starch; (3) "Polystal UII", which is a 50% or 70% solution of "Desmodur TH" in ethylacetate; (4) "Desmodur T", which is a mixture of 216 and 214 diisocyanate toluene; (5) "Desmodur TH", which is produced by reacting "Desmodur T" with Trimethylolpropane and butanediol; (6) various "Desmophens", made by reacting a polyhydric alcohol with adipic acid

On the Continent

alone or with phthalic acid; (7) "Maltopren", made by mixing "Desmophen S8", "Desmophen 800", and carbon black; (8) Kaurit, made by reacting 30% formalin with urea; (9) "Iporka," made by reacting urea, hexanetriol, and formalin. Flow sheets of some of the processes are also given.

Development of Room-Temperature-Curing Structural Adhesives for Metals, (Bjorksten and others). Bjorksten Research Lab., Inc., Madison, Wisc., 1954, 89p. Work has been directed toward a room-temperature low-pressure curing metal-to-metal adhesive suitable for the fabrication and field repair of certain air-frame structural parts where the use of heating and pressurizing equipment would be impractical or impossible. An adhesive consisting basically of methacrylic acid and methyl methacrylate, has been developed. Its development, formulation, processing and properties are presented.

Supplement to Above, 1955, 49p. A previous investigation on room temperature curing metal-to-metal adhesives resulted in the development of an acrylic adhesive which met the specified requirements except for its short pot life and open assembly time.

This booklet can be ordered from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Ask for publication number CTR-300.

• Tips on how to trade with the countries behind the Iron Curtain are being circulated on the European Continent. All countries which supply goods to the Soviet-Russian zone are warned to quote the same prices for the same products to all countries belonging to the Soviet Russian bloc. Recently, the countries belonging in the Soviet orbit organized a commission which has branches in all Soviet dominated countries including China, North Korea, North Vietnam and Outer Mongolia.

Suppliers in Western Europe will be registered in every country in the Soviet orbit and in Moscow in special files to be used to compare the various prices quoted for goods. Companies which quote different prices to the various countries in the Red bloc will be branded as capitalist vultures and will not be permitted to make deliveries to Soviet dominated countries. Furthermore, Soviet countries will attempt to barter a great amount of their export goods against industrial goods which they buy from the West.

This is not a new procedure. The Chinese are known to have been masters in this trading method. Soviet Russia, from time to time, uses the same tactics. It now looks as though henceforth all countries belonging to the Eastern bloc will use the same procedure. The European viewpoint is that factories in Western Europe which manufacture machinery and all kinds of industrial goods cannot be expected to open grocery stores for the sale of garlic, food of all kinds, textiles, and other merchandise which is more or less available in their own countries, for the sake of exporting some machinery.

• In America, recapped tires are serviceable for approximately 10,000 to 25,000 miles. Even during the war years, when there was very little rubber and rubber chemistry was not as advanced as it is today, it was possible to drive on recapped tires for at least 10,000 miles. At present, new tires are inexpensive and for this reason, recapped tires have lost some of their importance. The recapping process is very simple. Special practical machinery developed in the United States and the necessary camel-back plus American know-how is all that is needed for the production of a very good, inexpensive product.

An article which appears in the Soviet Union publication *Kauchuk i Rezina* (Rubber and Resins), demonstrates that in Russia, the recapping of tires is in its infancy and that the results obtained are very poor. It seems that Soviet Russia has neither the machinery, the experience, nor the raw materials to turn out a product which will meet the minimum requirements which prevailed in the country about 30 years ago. The report which was published in the June, 1958, issue, reads as follows:

Methods for Increasing the Life of Reconditioned Car Tires. Some conclusions and recommendations for improving the property of reconditioning materials, and for improving the technological processes for reconditioned tires, are given on the basis of recent investigations. The average wear of car tires reconditioned, according to the NIIShP method, is 25-30 000 km (approximately 16,000 miles), but it is pointed out that the average wear of tires reconditioned in various plants only reaches 10,000 km (6,000 miles). The properties of reconditioned tires depend on the composition of reconditioned stock, and on the properties of the materials used for reconditioning. Results are tabulated for reconditioned tires (260-20) after reconditioning of the tread according to the NIIShP method (1956-57). Correct vulcanization of the reconditioned tires is most important. Many reconditioning plants use "Vitakep" vulcanization chambers, but drawbacks of this method of vulcanization are pointed out, and it is recommended that car tires of standard dimensions should be vulcanized in individual vulcanization chambers. Physico-mechanical characteristics of reconditioning materials tested in the NIIShP are compared with rubbers used in the U. S. A. and Czechoslovakia. The tire factories supply various rubbers to the reconditioning plants which range from rubbers based on 100% NK to rubbers based on SKB with increased regenerate content. Various deficiences in the standard (Gost) for reconditioning materials are pointed out. The authors recommend that the existing standard for reconditioning materials be revised, and that the period of storing of the reconditioning materials before use should be shortened considerably. The methods for reconditioning should take into account the required improved qualities of the materials. The bonding between the materials and the casing of the tire should be increased by using adhesives filled with carbon black. Polyvinyl chloride, polyethylene, etc., and other plastics should be tested for use as new packing materials.

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- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Adhesive Bonding for Fibrous Glass Reinforced Plastics—H. A. Perry. $8.75.** A theoretical and practical manual on the joining of glass reinforced plastics. ☐

- **Adhesion and Adhesives—N. A. De Bruyne and R. Houwink. $13.50.** A collection of information on the scientific and technological aspects of adhesion. Part I deals with theory, while Part II is devoted to the technology of adhesion. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice —A. X. Schmidt and C. A. Marlies. $12.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives; their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research —G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Rubber-to-Metal Bonding—S. Buchan. $4.00.** Discusses methods for bonding natural and synthetic rubbers to metals of all kinds, for use by those who manufacture rubber-metal units, and of interest to the rubber-minded engineer. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Adhesion and Adhesives: Fundamentals and Practice—F. Clark, J. E. Rutzler, Jr. and R. L. Savage (Editors). $10.50.** Papers read at a Symposium at Case Institute of Technology and a Conference in London, on the status of knowledge in adhesion. ☐

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Thermal Degradation of Printed Wiring Adhesives

By T. D. SCHLABACH and D. K. RIDER
Bell Telephone Laboratories, Inc.
Murray Hill, New Jersey

One of the most critical factors, from a materials standpoint, in conventionally produced printed wiring boards is the adhesive bond between the copper cladding and the base laminate. The properties of this adhesive bond under the wide range of environments to which it may be subjected play an important role in determining the reliability and usefulness of printed circuits produced in this manner.

The problem of thermal degradation in printed wiring adhesives first came to our attention early in 1955 in connection with the proposed use of printed wiring boards in an oil filled power supply intended to operate continuously at 120°C. Since that time, an extensive study has been carried out covering the thermal aging characteristics of the adhesives used to bond copper in cladding laminates. Twenty different clad laminates, employing various thermosetting copper bonding adhesives, have been studied in detail, and an effort has been made to ascertain the cause of the thermal degradation observed.

Peel Strength Measurements

The thermal degradation referred to in this article has been followed exclusively by means of peel strength measurements on the adhesive bonded copper foil. The test specimen employed is shown in Figure 1 where peel measurements are made on each of the four ⅛-inch strips. In all cases the test specimens were prepared by etching the desired pattern on the clad laminate in a standard manner. This preparative procedure has been covered in detail elsewhere (*1*), and essentially involves application of the desired pattern using conventional photoengraving methods followed by etching in ferric chloride to remove the unwanted copper.

The thermal aging was carried out in a laboratory oven for the various temperatures and conditioning times desired. Temperatures of 82, 105, and 120°C. were employed, and the conditioning times ranged up to thirteen weeks. The temperature of 82°C. was chosen to closely approximate the maximum storage temperature for military equipment, 120°C. represented the operating temperature of the proposed power supply, and 105°C. was chosen as a convenient intermediate temperature which corresponded to the maximum continuous operating temperature for paper and other organic base laminates as given in A.I.E.E. Standard No. 1

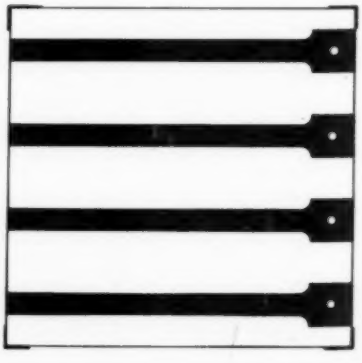
Following completion of the desired thermal aging cycle, the test specimens were cooled in air to room temperature and the peel strength determined. The extent of thermal degradation was judged by comparison with the peel strength for similar specimens which had received no thermal aging.

The actual peel strength values were determined using manual loading of a container with steel shot, and three values were obtained on each ⅛-inch strip. Since two test specimens were employed for each condition this gave 24 values for purposes of averaging. Comparison of manual loading results, which measure the load required to initiate peel, with those from an automatic testing machine (*1*), which measures the load required to sustain peel, indicates that the initiation values are 10-15 per cent higher.

The results obtained are listed in Table I. Those values which refer to thermal aging in oil were carried out in 10C Transil oil, and no attempt was made to prevent access of the air to the oil. As a result, heavy oxidation of the oil was observed at the end of the thirteen week conditioning period at 120°C.

In Table II are listed some results for laminates clad in our own laboratory. Commercially available unclad laminates of the type listed were used as the starting material, and the adhesive employed was a vinyl phenolic type (I-A) which was cured for 30 minutes at 325°F. and 500 psi in

Figure 1—Peel Strength Test Pattern



every case. The variables in these tests were chosen to aid in determining the cause of the thermal degradation observed, and the results will be discussed later.

Before entering into a discussion of the degradation with time induced by thermal aging it might be well to point out that peel strength generally decreases with increasing temperature. The effect on peel strength of increasing temperature, without any thermal aging, is shown in Figure 2 for several of the clad laminates included in this study.

These curves show the decrease to be most marked in the range of 90-130°C. with the 130°C. values being only 20-50 per cent of the room temperature values. The shape of this temperature dependence curve will vary from one adhesive system to another and as shown some will actually exhibit an increase in peel strength in going from room temperature to 90°C. but by the time 130°C. is reached all show a definite decrease (*2*). With somewhat brittle adhesives this behavior may be due to the slight softening that occurs at elevated temperatures which can confer a certain amount of legginess to the bond thus resulting in improved peel strength.

Internal Energy Content

The peel strength decrease generally observed upon heating is principally due to the higher internal energy content of the adhesive system at elevated temperatures, so that less external work is required to produce peel. In the sense that short excursions to these elevated temperatures are insufficient to cause permanent chemical alterations in these adhesive systems, it may be said that this effect is reversible. Under these conditions, lowering of the temperature will restore the original level of peel strength.

This is not the case with degradation induced by thermal aging, however, since the change observed is of a permanent nature resulting from an irreversible physicochemical alteration in the adhesive system. At considerably higher temperatures (*3*) oxidation of the copper itself may begin to play an important role in the decreased peel strength observed on thermal aging, but the temperatures under consideration here are well below this point.

Some of the thermal aging results for the commercially available clad laminates have been summarized in Tables III and IV. With three exceptions, all of the clad laminates tested exhibited some degree of degradation induced by thermal aging in air and oil. At the end of thirteen weeks thermal aging in air at 120°C. only 20-60 per cent of the original peel strength was retained while in oil only 25-45 per cent was retained.

A study of Table I will further show that the degradation at 82 or 105°C., through less than at 120°C., is still quite marked. Thus, of the 15 laminates which were thermally aged in air at 82°C., ten exhibited degradation and retained only 55-87 per cent of their original peel strength.

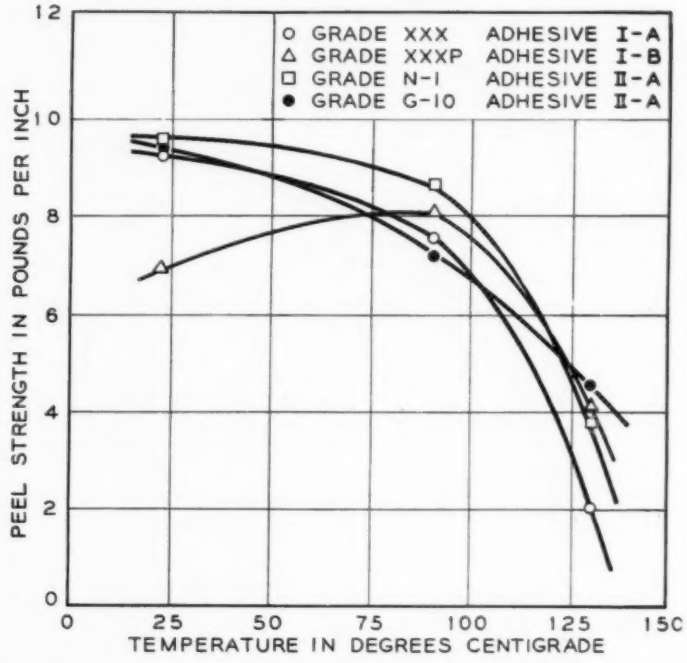
It can be seen from Tables III and IV that, with two exceptions, the ultimate amount of degradation is not greatly influenced by the type of adhesive system or base laminate used. There were ten adhesive systems, of three known basic types, involved in this study and eight of these systems exhibited degradation regardless of the type of base laminate involved. The two exceptions

Table I—The Effect of Thermal Aging on the Peel Strength of Clad Laminates

Base Laminate ASTM (MIL) Type	*Type of Adhesive Used*	*Copper Foil Thickness Inches*	*Conditioning Environment*	*Average Peel Strength, Pounds per Inch; Conditioning Time, Weeks* None	*1*	*4*	*13*
XXX(PBE)	Vinyl Phenolic	I-A 0.0014	82°C.	7.3	6.2	6.1	5.5
			105°C.	7.3	8.5	6.7	5.4
			120°C.	7.3	7.9	6.5	3.2
XXXP(PBE-P)	Vinyl Phenolic	I-B 0.0014	82°C.	11.3	10.6	9.9	9.8
			120°C.	11.3	9.9	9.2	4.9
			120°C. in Oil	11.3	10.8	8.2	2.8
G-5(GMG)	Modified Epoxy[1]	II-A 0.0014	82°C.	9.6	9.3	9.1	6.7
			105°C.	9.6	9.1	8.2	5.1
			120°C.	9.6	8.0	7.0	3.2
			120°C. in Oil	9.6	6.7	3.7	4.2
G-7(GSG)	Modified Epoxy[1]	II-A 0.0014	82°C.	11.3	9.3	8.0	6.4
			120°C.	11.3	10.5	8.8	5.6
			120°C. in Oil	11.3	9.3	6.1	4.8
G-10(GEE)	Vinyl Phenolic	I-B 0.0028	82°C.	18.5	15.4	14.6	13.1
			120°C.	18.5	9.1	9.0	6.3
G-10(GEE)	Vinyl Phenolic	I-A 0.0014	120°C.	12.8	10.1	11.0	6.6
G-10(GEE)	Vinyl Phenolic	I-C 0.0028	120°C.	17.2	18.1	15.5	7.2
G-10(GEE)	Modified Epoxy[1]	II-A 0.0014	120°C.	10.7	8.9	2.7	1.8
			120°C. in Oil	10.7	7.6	2.5	3.1
		0.0028	82°C.	12.2	10.8	9.9	10.3
			105°C.	12.2	10.8	10.8	7.9
			120°C.	12.2	6.2	3.6	2.6
G-10(GEE)	Modified Epoxy[1]	II-B 0.0028	82°C.	11.4	16.6	16.6	13.6
			120°C.	11.4	16.7	15.9	16.4
G-10(GEE)	Modified Epoxy[1]	II-B 0.0028	120°C.	13.3	11.8	12.7	13.0
G-10(GEE)	Modified Epoxy[1]	II-C 0.0014	82°C.	13.2	11.0	11.3	9.9
			120°C.	13.2	8.5	7.9	4.4
G-10(GEE)	None[2]	III-A 0.0028	82°C.	5.3	9.0	8.8	8.4
			120°C.	5.3	4.9	3.7	2.9
G-10(GEE)	None[2]	III-A 0.0028	82°C.	6.8	9.2	11.6	9.9
			105°C.	6.8	7.5	6.3	5.9
			120°C.	6.8	5.5	4.8	4.2
G-10(GEE)	None[2]	III-B 0.0028	82°C.	11.0	12.2	13.0	11.4
			105°C.	11.0	10.7	9.6	9.0
			120°C.	11.0	6.5	5.2	2.6
G-10(GEE)	None[2]	III-B 0.0028	82°C.	11.5	12.9	10.4	7.6
			120°C.	11.5	7.9	6.5	2.9
G-10(GEE)	None	III-C 0.0028	82°C.	12.9	13.4	13.2	11.3
			105°C.	12.9	9.3	6.8	4.7
			120°C.	12.9	7.3	6.5	7.5
N-1(NPG)	Modified Epoxy[1]	II-A 0.0014	82°C.	9.9	10.0	9.4	8.6
			105°C.	9.9	9.1	9.0	8.4
			120°C.	9.9	6.1	8.8	3.1
PTFE-Glass	Unknown	0.0014	82°C.	3.7	3.8	3.7	3.6
			120°C.	3.7	3.1	3.1	4.1

Note: [1]Generally modified with a vinyl-phenolic type of adhesive. [2]The epoxy resin of the base laminate is used as the adhesive in this case.

Figure 2—The Effect of Temperature on the Peel Strength of Various Clad Laminates



were the adhesive system used on the polytetrafluoroethylene-glass (PTFE-glass) laminate and the modified epoxy system (II-B) used on two different epoxy-glass laminates.

The exact identity of this PTFE-glass adhesive system is not known, and hence nothing can be said concerning its apparent resistance to degradation. It may be noted, however, that the initial peel strength for this particular laminate is quite low (3.7 pounds per inch) so that any degradation might be masked in this initially poor bond. Recent developments in bonding PTFE-glass laminates using a PTFE type polymer *(4)* result in considerably higher peel strengths (12-16 pounds per inch), and thermal aging of these for two weeks at 120°C. resulted in degradation amounting to 55-60 per cent of the original value.

In the case of the modified epoxy adhesive (II-B), a remarkable resistance to degradation is apparently present. Unfortunately, in spite of these high values, this adhesive is not recommended for use with epoxy-glass laminates since it does not properly coalesce with the base impregnating resin during the cure cycle. Since there are no results for this adhesive system used on a base laminate with which it is more compatible, it is difficult to say whether this adhesive is indeed more resistant to degradation or whether it merely appears so due to the base laminate used.

In an effort to isolate the cause of the observed thermal degradation, the laminates described in Table II were prepared. It was felt that possibly copper itself was catalytically aiding the degradation, and with this in mind clad laminates were prepared with aluminum foil (Grade 2S) and with copper which had been given a special oxide treatment.

If copper plays an important role in the degradation then proportionately less degradation should be observed when either aluminum or specially oxidized copper is used. The results obtained are summarized in Table V.

It can be seen that no marked differences are apparent in the ultimate amount of degradation observed. Further, the results indicate that the laminates made with aluminum and specially oxidized copper degrade at a rate that is only slightly less than for clean copper. From these results it appears that, at least with adhesive system I-A, the contribution due to copper is slight. The major portion of the observed degradation in the temperature range studied here must be attributed to heat and oxygen; in short, to the lack of thermal resistance present in the adhesive itself.

Similarly, this is probably the case also with the other adhesives involved which exhibit degradation. Since

Table II—The Effect of Thermal Aging on the Peel Strength of Specially Prepared Clad Laminates

Base Laminate ASTM (MIL) Type	*Type of Adhesive Used*	*Type of Foil Used and Thickness Inches*	*Foil Cleaning Method Used*	*Conditioning Environment*	*Avg. Peel Strength lbs. per in. Cond. Time Weeks None*	*1*	*4*	*13*
XXXP(PBEP)	Vinyl-Phenolic	Copper 0.0028	Solvent	120°C.	3.4	5.3	4.1	—
		Copper	Spec. Oxide Tr.	120°C.	17.1	15.3	12.9	12.5
	I-A	Aluminum 0.0018	Metasilicate	120°C.	2.5	3.2	2.5	1.7
	I-A	Aluminum	Sulfochromate	120°C.	12.7	10.4	10.3	10.2
G-10(GEE)No. 1	I-A	Copper 0.0028	Solvent	120°C	7.4	8.9	7.4	5.5
	I-A	Copper	Spec. Oxide Tr.	120°C.	17.8	15.4	15.4	13.6
	I-A	Aluminum 0.0018	Metasilicate	120°C.	4.9	6.4	5.6	2.8
	I-A	Aluminum	Sulfochromate	120°C.	12.3	12.1	11.9	10.8
G-10(GEE)No. 2	I-A	Copper 0.0028	Solvent	120°C.	7.6	10.2	10.0	6.9
	I-A	Copper	Spec. Oxide Tr.	120°C.	18.3	18.6	14.4	13.6

Note: Grade 2S aluminum was used in all cases.

Table III—Thermal Degradation of Various Copper Clad Epoxy-Glass Laminates Conditioned 13 Weeks in Air at 120°C.

Adhesive Type		*Per Cent of Original Peel Strength Retained*
Vinyl-Phenolic		
	(I-A)	52
	(I-B)	34
	(I-C)	42
Modified Epoxy		
	(II-A)	17
	(II-B)	144
	(II-B)	98
	(II-C)	33
None: The Epoxy Resin Used as the Adhesive	(III-A)	55
	(III-A)	62
	(III-B)	24
	(III-B)	25
	(III-C)	58

these others were only available on already coated copper foil, it was not possible to carry out the same type of testing as was done with the vinyl-phenolic (I-A) where the adhesive could be obtained separately.

It is interesting to note that the laminates prepared in the laboratory did not exhibit quite as much degradation as the commercial laminates employing the same adhesive system. It may be that the single stage cladding and laminating used on the commercial material alters the degradation characteristics as a result of dilution of the adhesive with the impregnating resin. This, of course, did not occur in the laboratory samples which were clad in a separate step.

Metal Foil Cleanliness

Another possibility involves the cleanliness of the metal foil. The foil used in the laboratory samples was specially cleaned, and prior experience from our own studies has indicated that poorly cleaned surfaces result in more rapid bond deterioration under severe environmental conditioning.

In all cases it was observed that the adhesive surfaces exposed to the air suffered considerable darkening upon aging at elevated temperatures. This darkening was also apparent underneath the conductors at their edges; extending as much as 1/32 inch in from the edges in some cases.

This exposure to oxygen at elevated temperatures, in addition to causing degradation of the bond, may also affect the insulation resistance of the printed wiring board. That portion of the degradation leading to low molecular weight material having poorer electrical resistance could adversely affect the insulation resistance which is of considerable importance in printed circuit applications. In fact, it is this high insulation resistance requirement which limits the type of adhesive systems that may be used in these applications. Thus, for example, the addition of nitrile rubber to the adhesive system to improve peel generally results in inferior electrical properties.

The results of this study indicate that the majority of printed wiring adhesives used at the present time will exhibit marked thermal degradation upon aging at elevated temperatures. The extent of this degradation increases with increasing temperature, but is still apparent at temperatures as low as 82°C. The ultimate amount of degradation observed is more or less independent of the adhesive type and base laminate.

Probably only a small portion of the degradation can be attributed to any catalytic action by the copper; the major portion of the degradation being caused by the combined effect of atmospheric oxygen and temperature. It might be that improved surface cleanliness of the foil could result in decreased degradation. The attendant surface darkening which occurs on the exposed adhesive may also adversely affect the insulation resistance, and this aspect of the problem requires further study.

The practical significance of these results for printed circuit applications is that the limits regarding the maximum continuous operating temperatures for clad laminates must be revised. It is generally stated or implied that clad laminates may be operated continuously at the same temperature which governs the base laminate itself. That is, 105°C. for paper or other organic base laminates, 130°C. for glass base laminates other than those using silicone or polytetrafluoroethylene, and 180°C. for these last two polymers when reinforced with glass in accordance with the A.I.E.E. Standard No. 1.

Operation in these temperature ranges for a prolonged period would result in the degradation discussed

Table IV—Thermal Degradation of Various Copper Laminates Conditioned 13 Weeks at 120°C.

Base Laminate ASTM (MIL) Type	*Adhesive Type*	*Per Cent of Original Peel Strength Retained*
XXX (PBE)	Vinyl-Phenolic (I-A)	44
XXXP (PBEP)	(I-B)	25
G-5 (GMG)	Modified Epoxy (II-A)	33
G-7 (GSG)	(II-A)	50
G-10 (GEE)	(II-A)	17
N-1 (NPG)	(II-A)	31
PTFE-Glass	Unknown	111

Table V—Thermal Degradation of Specially Prepared Clad Laminates Conditioned 13 Weeks in Air at 120°C.

Base Laminate ASTM (MIL) Type	*Metal Foil Used*	*Foil Cleaning Method*	*Per Cent of Original Peel Strength Retained*
G-10(GEE) No. 1	Copper	Solvent Only	74
		Spec. Oxide Treat.	76
G-10(GEE) No. 2	Copper	Solvent Only	91
		Spec. Oxide Treat.	74
G-10(GEE) No. 1	Aluminum	Metasilicate	57
		Sulfochromate	88
XXXP(PBE-P)	Copper	Spec. Oxide Treat.	73
	Aluminum	Metasilicate	68
		Sulfochromate	80

Note: Vinyl-phenolic adhesive (I-A) used in all cases.

About the Authors . . .

DON K. RIDER is in charge of the development of adhesives, laminates and casting resins for Bell Telephone Laboratories, Inc. In 1957, he was chairman of the Gordon Research Conference on Adhesion.

TOM D. SCHLABACH is a member of the Bell Telephone Laboratories' Technical Staff. For the past four years, he has been working in chemical aspects of printed wiring, including the development of test methods, materials, and process evaluation.

here, and in addition a further loss in peel strength would be encountered due to the general lowering of peel strength at elevated temperature. In other words, the degradation effect would be superimposed upon the decrease peel strength at the higher temperature. The combined effect could easily lead to very low peel strength, and failures could occur readily in such cases if any shock or vibration loading was introduced or if the printed wiring conductors were involved to any extent in mechanically supporting the components present.

It would appear that continuous operation at temperatures below 80°C. (176°F.) should not cause any serious problem, but at temperatures beyond this, individual consideration should be given to the particular application in question so that adequate design steps can be taken.

At the present time the entire question of thermal degradation of printed wiring adhesives is being considered by Committee 40C of Electronic Industries Association. This work is being directed towards establishing useful life of the bond versus temperature in much the same manner as now being done for the basic insulating material itself, and as described by Dakin (5) and others. If successful, this work would provide for a more rational temperature classification of clad laminates, and would prompt revision of present bond strength tests such as those presently used by Underwriters Laboratories in testing printed circuits made from copper clad laminates. It is unfortunate that the data which is presented here is insufficient to permit testing the validity of such an approach, but it is hoped that other investigators may be able to do so in the near future.

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(4) McElroy, D. E., and Stein, S. J., Elec. Mfg. Vol. 60 126 (1957) Oct.

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Modified Epoxy Solves Shattering Problem

In efforts to use mechanical fastening to attach a large cast aluminum plaque to the window of a New York Savings Bank branch, contractors twice shattered the expensive plate glass. Architect John Weber felt that some form of adhesive bonding was called for and turned to Preco Chemical Corp., Farmingdale, N.Y., for help.

Though an epoxy adhesive would definitely be able to bond the 24-inch aluminum disk to glass, Preco engineers reasoned that greater flexibility would be required in order to absorb the vibrations from high winds and heavy traffic. At their suggestion, an epoxy modified with sulfurized synthetic rubber polymers was used.

The material proved to be an excellent glass-to-aluminum bondant and, in addition, offered shock-cushioning flexibility which helps guard the window against vibration shattering. Within tempting reach of passers-by, the plaque has resisted all efforts of man and boy to remove it.

The large aluminum plaque was bonded to the plate glass window with a special epoxy-polysulfide-rubber adhesive designed to meet unique service requirements.

Elastomeric Adhesives Production

Successful manufacture of rubber-based adhesives hinges on precise formulations and accurate compounding technology

By A. J. BRUNO
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"Elastomeric adhesives" can be broadly defined as adhesives which contain rubber or a rubber-like material as a major ingredient. Adhesives of this type normally form tough flexible joints and are extensively used for a wide variety of structural and non-structural bonding applications.

A high degree of technical and manufacturing skill is required to formulate and produce elastomeric adhesives possessing just the right viscosity, tack, adhesion, setting speed, cohesive strength, shear strength, peel strength, oil resistance, solvent resistance, heat resistance and aging properties. Because of the complex nature of most of these compounds, only a very general description of the composition of such adhesives can be given here.

Elastomers most commonly used in adhesives are natural rubber, reclaimed rubber, Buna N (nitrile rubber), SBR (butadiene-styrene rubber), neoprene, polyisobutylene and polyvinyl ether. In commercial practice, the base elastomers are almost always modified with thermoplastic (rosin, rosin esters, polyterpenes, etc.) or thermosetting (phenolic, epoxy, etc.) resins. Other ingredients commonly used in elastomeric adhesive formulations are fillers (whiting, clay, etc.), reinforcing agents (zinc oxide, carbon black etc.), antioxidants, vulcanizing agents, oils, plasticizers, emulsifying agents, solvents and water. The few all-elastomer adhesives (elastomer dispersed in solvent or water) commercially available today find only very limited use as low strength cements for bonding paper and similar materials.

Bonding of elastomeric based adhesives is generally accomplished by pressure (pressure-sensitive and contact type adhesives), heat (thermosetting or vulcanizing adhesives), solvent release or water evaporation.

Natural and reclaim rubber based adhesives normally possess excellent tack and tack retention, excellent water resistance, fair to good shear and peel strengths but poor resistance to oil and solvents. They are used extensively to bond paper, rubber, plastic films, leather, wood, ceramic and plastic tile, plasterboard, metal etc., to each other and to various other substrates. The adhesives used on many pressure-sensitive tapes such as masking tape, cellophane tape and cloth tapes, are frequently natural or reclaim rubber based. The properties and uses of SBR rubber adhesives are normally quite similar to those of natural rubber adhesives.

Oil-Resistant Types

Neoprene and Buna N adhesives are generally characterized by good oil and hydrocarbon solvent resistance, excellent shear and creep resistance, and good elevated temperature resistance when compounded with thermosetting resins. Phenolic neoprene adhesives are frequently used for the bonding of metals, wood and plastics in structural applications. Surfaces pre-coated with certain types of neoprene based adhesives, bond well to each other but not to foreign surfaces. As such, they are known as "contact" adhesives.

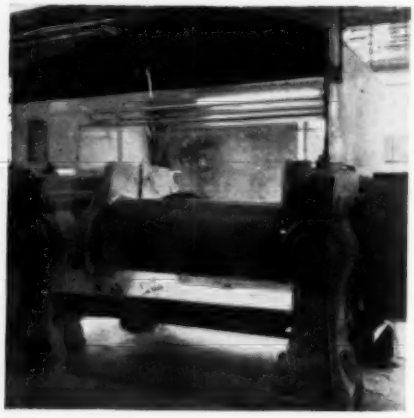
Buna N adhesives, particularly when compounded with phenolic resins, are widely used for bonding brake linings, grinding wheels and various metal surfaces. They are also used as general purpose and shoe sole cements. Polyisobutylene and polyvinyl ether adhesives generally exhibit good tack and tack retention, good shear strength and creep resistance, excellent transparency and outstanding aging properties. In addition to general purpose applications, they are frequently employed as pressure-sensitive label adhesives.

The characteristics of adhesives

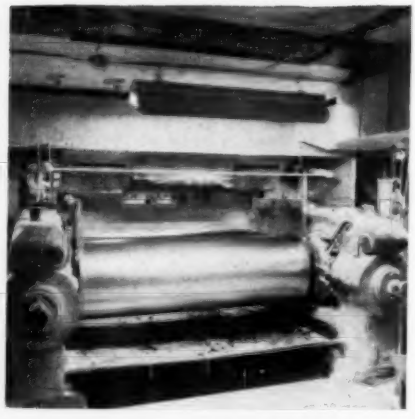
About the Author . . .

ARTHUR BRUNO joined the Johns-Manville Research Center in 1950 as a chemist in the Organic Specialties Section. In 1955, after his research studies on adhesives and tapes, he became chief of the Research and Development Group working on these products. He was appointed associate technical manager of the Dutch Brand Division in 1958. Dr. Bruno received his Doctorate in Organic Chemistry from Clark University in 1950.

Bales of raw Venezuelan rubber arriving at the J-M plant go to storage areas and then to compounding rooms for weighing and blending. 1



Rubber mills, generally used for processing smaller batches, break down the base elastomer and disperse the added dry ingredients. 2



The compounded elastomer next goes to the sheeting mill where it is worked into sheet form in preparation for the following step. 3

Taylor-Styles rubber cutters slit the slabs of milled rubber into spaghetti-like strips which are fed into the churning machines. 4

based on any particular elastomer can be varied considerably by proper compounding. For example, the Buna N types can range from adhesives having high tackiness and high peel strength but low shear strength, to grades with poor tackiness but high peel and shear strengths. Compounding can also permit considerable variation in other properties such as creep resistance, heat resistance, flexibility, water resistance, solvent resistance, etc.

Discussion on the manufacture of elastomeric adhesives will be limited to the solvent dispersed type. The first step in the production process is compounding of the required raw materials. Most of the elastomers used are purchased in bale form and have to be cut into smaller pieces for efficient weighing and processing. This is accomplished by means of guillotine-type cutters which can be adjusted to provide pieces of any size desired. The base elastomer, fillers, antioxidant, and other ingredients which go into the dry milling portion of the batch are carefully weighed on a batch basis, placed in clean tote boxes and conveyed to the mill room for processing.

Either two-roll rubber mills or Banbury mixers are used to accomplish breakdown of the base elastomer when necessary and to disperse intimately the dry ingredients in the elastomer. The rubber mills are generally used for processing the softer, smaller mixes while the Banbury is more effective and economical for larger batches and heavy tough stocks.

In mill mixing, the first step normally taken is to pass the elastomer through tight rolls until a continuous sheet which clings to one of the rolls is formed. In order to achieve efficient milling, the quantity of elastomer used must be sufficient to permit formation of a small rolling bank at the nip of the rolls.

Due to the fact that the two rolls rotate at different speeds, the elastomer is exposed to considerable shearing action as it passes between the rolls. This mechanical shearing action actually results in depolymerization of the elastomer molecules. The function of this step in the milling cycle is to breakdown or soften the elastomer to the desired plasticity.

Milling is continued in this manner until the desired plasticity as determined by a Mooney or Williams plastometer is achieved. Since temperature has a pronounced influence on the rate of breakdown (breakdown normally occurs more rapidly when the batch is cold), the temperature of the mill rolls must be con-

trolled accurately during the milling process by passing steam or refrigerated water through the rolls. The length of time required for this step in the process varies considerably depending upon the extent of breakdown desired and type of elastomer used. Natural rubber can be broken down quite readily whereas the synthetic elastomers are quite resistant to mill breakdown and may require the use of chemical plasticizers to assist in accomplishing suitable breakdown.

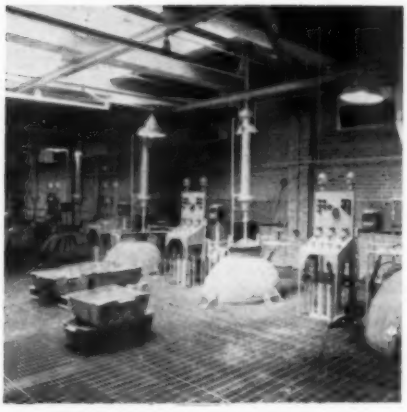
When the elastomer has been plasticized or softened to the desired extent, the antioxidant, fillers and other compounding ingredients are then slowly added to the rolling back of elastomer. Continued milling results in intimate dispersion of the ingredients in the elastomer. Since considerable heat is built up during milling, even when the mill rolls are refrigerated, vulcanizing agents, when used, are normally added last and worked into the batch as rapidly as possible.

When mill mixing has been completed, as determined by quality control checks, the finished batch is cut off the mill in slabs approximately ¼ inch thick, 18 inches wide and 5 feet long. The slabs are then hung on racks to cool.

Since accurate batch to batch reproducibility is essential, all batches are milled to close plasticity tolerances. The total mill time frequently varies considerably for batches of the same adhesive stock due to variations in the plasticity of the base elastomer as received. Raw material plasticity variations are particularly pronounced in the case of natural rubber. For this reason, it is necessary to check closely incoming raw materials. It is advantageous to segregate elastomers such as natural rubber according to plasticity ranges or to blend lots of incoming material.

Banbury mixing is similar in principle to mill mixing. This type of heavy duty internal mixer consists of two heavy rotors with interrupted spiral edges which rotate within an enclosed chamber. The rubber and compounding ingredients are charged into the mixing chamber from above and are held in the chamber during mixing by means of an air operated ram.

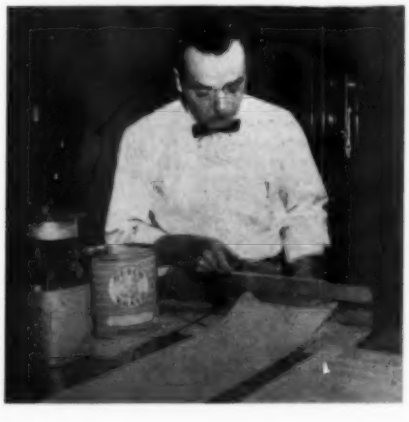
The mixing and masticating action occurs between the rotors and the walls of the mixing chamber. Mixing time is influenced by the temperature of the batch, clearance between the tips of the rotors and the chamber walls, and speed of the rotors. The rotors are cored and the walls jacketed in order either to cool or



5 **Tubs of "spaghetti" and controlled quantities of resins, plasticizers and other ingredients are semi-automatically emptied into mixers.**

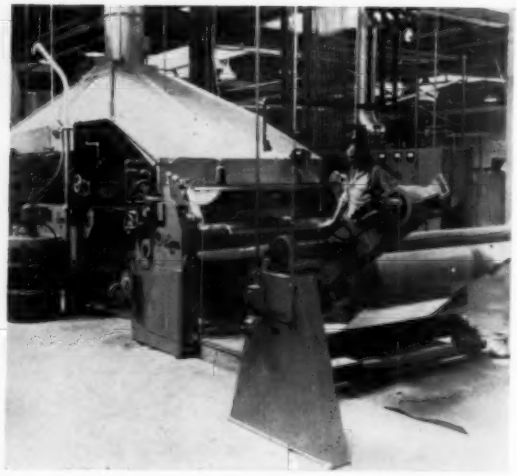
6 **The adhesive is pumped into storage tanks where it is subject to constant agitation to prevent it from either settling or separating.**

7 **Finished elastomeric adhesive required within the plant or for commercial use is strained into drums for transportation.**

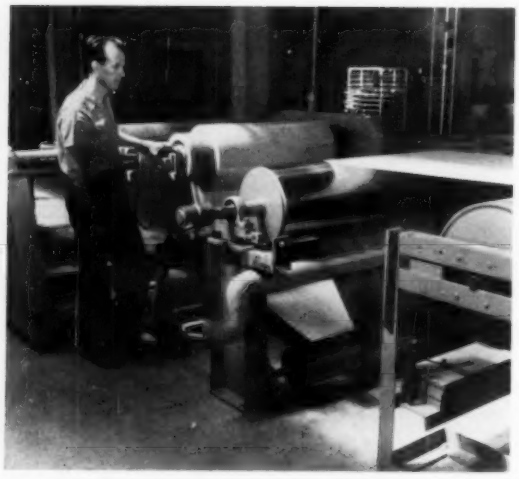


8 **Research chemist applies experimental pressure-sensitive adhesive to flatback paper as part of a series of development tests.**

PRESSURE-SENSITIVE ADHESIVE TAPE PRODUCTION



Two interchangeable heads on this adhesive coater permit fabrication of a wide range of tape products within the production cycle.



After tapes pass through 40-foot ovens, they go to a winder unit. This photo shows the take-off end of the ancher coating equipment.

Finished pressure-sensitive tapes are speeded through the packaging operation by an automatically controlled Wrap-King unit.

heat the mass by water or steam. The mixing procedure itself consists of masticating or softening the elastomer to its proper state and then adding the compounding ingredients.

The order of addition is very important. Since for good dispersion a fairly stiff mix is essential, fillers are added slowly and softeners are added near the end of the mixing cycle. The mixed material is discharged through a sliding door in the bottom of the trough to a sheeting mill directly beneath the mixer. The stock is then cut off the mills in slabs in the same manner described for mill mixing.

The slabs of milled stocks are conveyed to the adhesive mixing department for further processing. It would be quite impractical to throw the big slabs of milled rubber in the churning machines because of the excessive time required to dissolve these big pieces of stock. In order to avoid this, the slabs of rubber are cut into thin narrow strips by means of a Taylor-Styles rubber cutter. These narrow strips, which resemble spaghetti in appearance, are loaded into tubs and brought by an over-head monorail system to the churn designated to mix the specific cement batch.

Three general types of churns or adhesive mixers are used:

(A) Heavy duty Sigmablade slow speed mixers are generally used for pastes, doughs and very high viscosity cements.

(B) Horizontal T blade-churn types (T shaped blades mounted spirally around a central shaft in a cylindrical vessel) used for lower viscosity adhesives which disperse quite readily.

(C) High speed enclosed propeller-type mixers use a marine type propeller agitator with a mixing tank of stream-lined design which insures a rapid turnover of the content, thereby subjecting the rubber to the violent shearing and cutting actions of the propeller blades. A uniformly smooth lump-free cement is produced in a fraction of the time ordinarily required by slow speed mixers.

Tubs of "spaghetti" are semi-automatically emptied into the mixers along with accurately weighed quantities of resins, plasticizers and other ingredients. Solid resins are previously crushed by hammer mills for efficient and rapid dispersion in the adhesive batch. Liquid and semi-liquid resins are stored in drums in a heating room; heating lowers viscosity and facilitates entrance into the mixers. Solvents are automatically metered into the mixers from stor-

age tanks, exact quantities required are pre-set on electronic control panels.

The mixing cycle lasts from two to ten hours and is dependent on the churn being utilized and the type of adhesive being manufactured. Prior to tapping the mixers for adhesive storage, samples are withdrawn from all batches. These samples of adhesives are checked for total solid content, viscosity, adhesion and other physical characteristics to prove that the finished adhesives meet all of the necessary product requirements.

After the mixing cycle is completed, the cement is pumped through specially designed filters in order to remove any impurities that may have been present. These impurities, for example, can be sand or grit which enter the bales of raw rubber during plantation processing. The cement is then pumped into storage tanks where it is kept under constant slow speed agitation to prevent settling or separation until such time as it is used in an internal coating operation or tapped into cans or drums for commercial use.

A Short Guide To
Better Wood Bonding

By D. DEBNAR
Dural Products Limited
Plattsburgh, N.Y.

Because the process is several thousand years old, most people take good wood gluing for granted and any failure in performance is put on the glue or on the glue manufacturers. In most cases, however, many difficulties can be overcome and glue failure eliminated by a more complete knowledge of the characteristics of the wood itself.

It should be emphasized that wood is a living element and that it does not die when the tree is cut. It is of tremendous importance to the woodworker to keep this in mind all the time.

Before going further into the characteristics of wood, however, it might be best to set down its composition:

(1) 40-50 per cent cellulose
(2) 20-30 per cent lignin
(3) 20-25 per cent wood polyose

to bind the cellulose and lignin together.

Knowing this we can easily realize that wood coming from the forest has not only solid cellulose, but also a lot of moisture. Generally, we can say that wood after it is cut has a moisture content of about 35-40 per cent. Since wood can only be bonded together if the moisture content is not higher than 7-10 per cent, we can immediately recognize the importance of knowing how to dry out the wood's surplus moisture and how to measure the moisture content.

Air drying is the most common method of eliminating surplus moisture. However, it requires a large storage area as well as tying up working capital for a long time. In addition, when air drying alone is employed the moisture does not go below approximately 13 per cent. Beyond this point, the drying is influenced too much by atmospheric conditions of the storage room, outside temperature, etc.

It is of great importance that the modern woodworker dry the wood mechanically so that the operation can be completed quickly and the wood brought to the moisture content required for safe, successful and trouble-free work. General recognition of the importance of controlled drying can help eliminate a lot of failures both in gluing and other woodworking operations. Experience has shown that many glue failures can be traced to the wood's high moisture content.

Moisture Content

It is absolutely necessary, therefore, not only to dry the wood, but to check its moisture content before starting to work with it. Inexpensive and easy to handle equipment is commercially available and there is no excuse for woodworkers to run the risk of glue failure due to high moisture content.

Though many other factors—such as the difference between soft wood or hardwood—will affect the gluing operation, proper drying and checking of the wood's moisture content are of the greatest importance. It is also important, however, that the assembly to be bonded be properly prepared, and that the manufacturer's instructions be followed as to the handling of the glue. Some of the failure factors coming under these headings include:

(1) Gluing at insufficient temperature.
(2) Uneven or improper glue application.
(3) Uneven, insufficient or too much pressure.
(4) Running over the glue's open assembly time.
(5) Insufficient pressing time.
(6) Improper assembly construction.

All these points have to be taken into consideration if gluing problems are to be eliminated. To blame the glue alone will result in confusion, wasted time and more failure.

About the Author

Mr. Debnar studied at the University of Prague and at the University of Vienna and was engaged in chemical research in Germany and in Czechoslovakia before he came to Canada in 1949. While in Czechoslovakia, he founded a gelatine and synthetic adhesive plant. In Canada, he founded Dural Products. In 1957, the company opened a branch plant at Plattsburgh, New York.

Types of Bonds Involved in Adhesion

PART TWO of this investigation into the types of chemical forces active in adhesive bonds focuses attention on the systems involved in adhesion to wood, cellulose and metals

By JOHN E. RUTZLER, JR.
Case Institute of Technology
Cleveland, Ohio

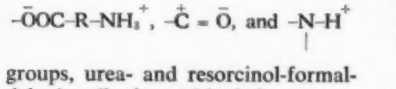
The types of adhesive bonds which wood and cellulose form would not be expected to be greatly different from those encountered in systems involving glass. Freshly abraded or cut cellulose and wood surfaces would be expected to contain

groups and some

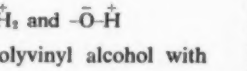
groups like the

groups in the glass surfaces, along with highly reactive carbon and oxygen atoms that also have had one or more of their bonds to other atoms severed by the mechanical action. Mechanical abrading or roughening of glass gives a surface with similar valence unsaturated atoms in it and strong adhesion to roughened glass surfaces has been found.

Animal, casein, and albumin glues with their



groups, urea- and resorcinol-formaldehyde adhesives with their



groups, and polyvinyl alcohol with its

group, all adhere strongly to wood and/or cellulose (*27*) (*28*). The mechanisms by which these adhesives probably bond to wood and cellulose and the contra-adhesion influences that are active can be arrived at by matching the polar groups involved to surfaces such as those shown in Figures 6A and 6B for glass and applying the discussion of the adhesion to glass to cellulose-adhesive systems.

Cellulose nitrate adheres strongly to cellulose and weakly to glass probably because of similarity of structure and atomic spacing in the one case and marked dissimilarity in the other. The fit factor probably is especially effective in promoting adhesion of cellulose nitrate to cellulose because the chains of the adhesive are relatively stiff and not coiled in solution (*29*).

Adhesion to Metals

High polymers adhere to metal surfaces by several different mechanisms and the adhesive-metal systems probably involve the widest variety of kinds of bonds of any adherend-adhesive systems that are presently of practical importance. To understand the nature of the forces of interaction in these systems requires a knowledge of the nature of the metal surface which seldom is known in any detail, largely because of the many and varied surface treatments applied to metals prior to bonding.

Fortunately, the problem seemingly can be simplified by choosing to consider the types of bonds that might form between adhesives and metal surfaces that have been prepared for bonding by dry-machining and maintaining them in a dry atmosphere. Except in the case of gold, such surfaces will have on them either a chemisorbed layer of oxygen or of hydroxyl groups, the adhesion of a number of different adhesives to the former being stronger than to the latter (*30*).

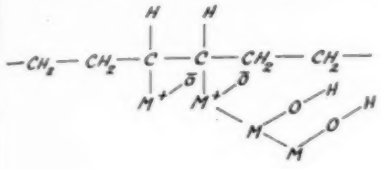
The difference in electronegativity between most metals and oxygen is sufficiently large so that the surface oxide consists of oxygen ions, the degree of ionic character varying with the electronegativity of the metal. Further to simplify the problem of provisionally identifying the types of bonds occurring between adhesives and metal surfaces, the discussion is limited largely to the oxide-coated surface. Such a surface can be produced by strongly heating the dry-machined metal prior to bonding.

On a completely ordered metal oxide surface the oxygen ions occupy the outermost plane of contact of the surface with the metal ions located slightly below them. Consequently, the metal ions are in less geometrically favorable positions for close approach by groups on the adhesive molecule. However, this geometric inaccessibility of the metal ions need not, and probably does not, persist over the whole polycrystalline surface of the ordinary metal to which adhesive bonds are made. As a result chemisorption with covalent bond formation can, as Trapnell points out (*31*), involve the metal ion.

Because of the variety of mechanisms by which adhesion to a metal oxide surface may take place, the discussion of types of bonds in these systems is broken down into bond types instead of type of adhesives as was done for glass.

A. Covalent bonds to metal surfaces—There is a considerable body of evidence, derived in large measure from the field of contact catalysis, that covalent surface bonds form between metal and metal oxide adherends and many different molecules all the way from room temperature to the higher temperatures frequently employed in bonding metals by means of adhesives. This evi-

Fig. 7—Bonding Methylene Groups to Metal Oxide Surface



Note: Hydrogen goes off as H_2O

dence is discussed in detail by Trapnell and by Eischens (*31*).

Following Trapnell's views, several types of covalent bonds probably can and do form in the adhesion of a number of resins to metal surfaces. Since these bonds are very strong, very few of them would be required to give large strengths of adhesion. It is reasonable to believe that polyethylene, polystyrene and adhesives having long chains of methylene groups will anchor, at least to some degree, to a metal oxide surface, in the manner similar to that indicated in Figure 7, with the elimination of two atoms of hydrogen.

$$M^{+} - M^{+}$$

in this figure represents the the metal ions in the surface oxide.

Such an interaction probably results from bonding with atomic d-orbitals when the metal is one of the transition metals. Polyvinylbutyral and Nylon form almost as strong bonds with steel and aluminum as epoxy adhesives—in the neighborhood of 6000-8000 psi in tension (*18*). Though the polar groups on parts of the chains undoubtedly contribute to the observed bond strengths, covalent bonding of methylene groups in a manner similar to that shown in Figue 7 quite probably plays a role in the adhesion.

Addition of rubbers to phenolic adhesives improves bond strength by adding flexibility to the chains. It seems likely that the adhesion also is improved as a result of some covalent bonding to the metal surface, as suggested respectively by Figure 7 and one or the other of the types of bonding in Figure 8. In Figure 8A the double bond of polybutadiene is left intact and hydrogen is eliminated while in Figure 8B the double bond is broken to form the covalent surface bond.

For bonds of the types suggested by Figure 8 to contribute a great deal to the adhesion, the spacing of the metal ions in the surface might be critical and this factor would probably keep the number of such bonds to a minimum. However, the attachment of the adhesive to the surface need not be through contiguous carbon atoms. The fact that polybutadiene does not itself adhere well to metals does not vitiate these mechanisms because experiments designed to elucidate the mechanism, using adequately cleaned surfaces, seem not to have been performed.

The role of the phenolic portion of the adhesive in the adhesion of phenolic-rubbers undoubtedly is more important than that of the rubber portion. Polyvinyl chloride might attach to the metal surface much as shown in Figure 8B with the chlorine atoms in the place of the two single hydrogen atoms.

B. Coordinate bonds with the surface—A tendency to form coordinate links, one atom supplying both electrons of the bond between a pair of atoms, would be expected to be present when adhesives containing tricovalent nitrogen are brought into contact with metal surfaces. The transition metal ions are particularly prone to form coordinate bonds in solution (*32*) and Trapnell (*31*) concludes that bonds of this nature may be formed in the chemisorption of molecules containing atoms of the nitrogen and oxygen groups of the periodic table when these atoms possess lone electron pairs in the compounds.

Some possible types of surface coordination compounds that might occur in adhesive-adherend systems are illustrated in Figure 9 for nylon on steel and a 2,4 tolylenediisocyanate on a titanium surface. The nylon complex postulated for an iron surface in Figure 9A is essentially a chelate with a five-membered ring involving an ion-dipole link between the carbon of the ketone group and the oxygen of the surface and a coordinate bond between iron and nitrogen. Such an arrangement would be more stable and result in stronger adhesion than the cordination of the nitrogen alone.

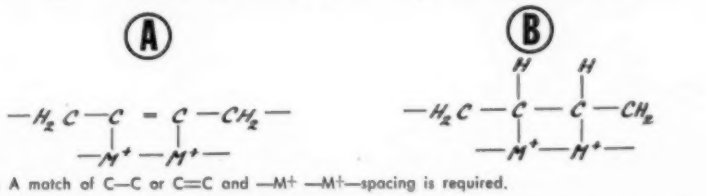
However, the geometry is not very favorable to the formation of many such chelate bonds. Epoxy resins cross-linked with amines may owe at least a portion of their adhesion to surfaces of transition metals to complexes in which nitrogen is coordinated to the metal ion as in Figure 9A. Gelatin also would be expected to show some of this type of bonding to a metal surface.

Since the coordinate bond is essentially covalent in character after it is formed, interactions such as those depicted in Figure 9 would help to account for the high strength required of surface bonds in adhesion because of the probable small number of points of attachment to the surface.

C. Ionic surface bonds—Adhesive systems containing carboxyl groups such as copolymers containing acrylic acid, the polyacrylic acids themselves, carboxylic rubbers, and resins containing phenolic hydroxyl groups almost surely bond to the surfaces of metals largely as a result of ionic interactions. One notes, in the case of the phenolics, that the hydroxyl group is much more ionized than is water. With respect to the bonds formed between carboxyl groups and surface oxides, there is abundant evidence that soaps are formed between metal oxides and long chain fatty acids by chemisorption from solution (*33*) and the author has found strong evidence for such soap formation by chemisorption of oleic acid on brass from mineral oil solution.

Smith and co-workers (*33*) carried out extensive studies of soap formation between metal surfaces and n-nonadecanoic acid. They found that many metals form soaps with this acid. In their first paper, they attributed this to hydrogen bond formation typical of those formed in metal chelate compounds. While stable

Fig. 8—Possible Modes of Bonding Rubber to Metals



Note: A match of C—C or C=C and —M+ —M+—spacing is required.

complexes are formed by coordination between free ions by reactions such as *(32)*

$$Fe^{3+} + 3C_2O_4^{--} \rightarrow Fe(C_2O_4)_3^{---}$$

it is difficult to see how this would occur on an iron surface because the geometry of the three carboxyl groups and the iron would tend to restrict the approach of the former to the latter sufficiently to prevent bond formation.

In a metal oxide the surface reaction

$$-Fe^{+}-\bar{O}+2RCOOH \rightarrow Fe\begin{matrix}OOCR\\OOCR\end{matrix}+H_2O,$$

seems more probable when the long chain acid molecules, RCOOH, are free to orient upon the surface. The $Fe^{+}_{-}\bar{O}$ structure of the surface of iron is the most probable one on a fresh surface after moderate exposure to oxygen *(34)*. Smith and coworkers found that metal soaps were not formed with platinum and gold, but were formed with less noble metals.

They also showed that bonding can result from soap formation when the surface of the metal consisted of metal ions and had no oxide on it. The metal surface was prepared out of contact with oxygen and exposed to solutions of n-nonadecanoic acid under the same condition. Machining the metal in absence of oxygen caused the metal to emit electrons long enough for the following surface reaction to take place

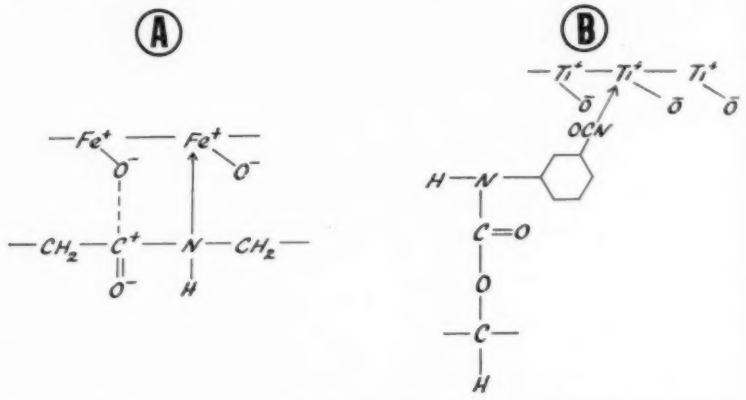
$$1/2\ Cu + C_{18}H_{37}COOH \rightarrow$$
$$1/2\ Cu(C_{18}H_{37}COO)_2 + 1/2\ H_2$$

Freshly machined metal surfaces kept out of contact with oxygen, even during application of the adhesive, might be expected to form bonds by this mechanism with adhesives containing carboxyl groups.

Become Linked Chain

When the carboxyl groups lose freedom of movement in space as a result of being part of a linked chain, as in an adhesive, geometric considerations make it seem quite unlikely that there would be many molecular or atomic sites at which two carboxyl groups would react with a surface oxide ion to form a soap such as those found by Smith and co-workers. For the same reason, two hydroxyl groups of a phenolic resin would be unlikely to pick up an oxygen ion from the surface of a metal.

Fig. 9—Interactions of Surface Coordination Compounds



Note: A—Nyon on iron surface nitrogen supplies two electrons for sharing with iron. B—Diisocyanate coordinated to titanium surface.

Likely types of ionic interactions between metal oxide surfaces are illustrated in Figure 10, in which A represents ionic bonding of the carboxyl group to a metal oxide surface and B represents a similar bonding of a phenolic hydroxyl. These are ionic bonds in the sense that the metal-oxygen bond is more than 50 per cent ionic in character and the —O —H bond of the carboxyl or phenolic hydroxyl group is partly ionic in character. The less the electronegativity of the metal and the more ionizable the hydrogen of the adhesive molecule, the stronger will such bonds as those postulated in Figure 10 be.

This does not mean that there will of necessity be stronger practical adhesion between a given phenolic or carboxylic resin and magnesium, with an electronegativity of 1.2, than between the same resin and aluminum with an electronegativity of 1.5 or titanium with an electronegativity of 1.6 for the reason that in practice one almost surely would not have the same number of sites of interaction on three such surfaces, and since there are probably very few bonds anyway, small differences in the number of sites of interaction would number to relatively large differences in percentage of effective sites.

D. Ion-dipole bonds—Ion-dipole bonds in glass systems were discussed in some detail when we were considering glass surfaces. This is at least part of the mechanism by means of which water is bonded to ions in solution. Since the difference in electronegativities between metals and oxygen is markedly greater than between silicon and oxygen, stronger ion-dipole interactions would be expected on a metal oxide surface than on a

$$-\overset{|}{\underset{|}{Si}}-\bar{O}$$

surface.

The assumption is made for all these surfaces that the dipoles resulting from the partial ionic character of the surface bonds do not cancel completely along the surface. Contentions have been made both ways on this point, but this is not a suitable place to referee them.

The ion-dipole interaction would be expected to contribute to adhesion in those metal-adhesive systems in which the polar group of the adhesive is not ionic. The group dipole moments of the effective bonding groups of adhesive molecules can be taken pretty much as relative measures of the strengths of interaction of a series of adhesives with a given metallic oxide surface, if the whole bonding force arises from this cause.

However, the probability is that the ion-dipole mechanism is only one of several mechanisms that operate to cause adhesion in these systems. The —CN group of polyacrylonitrile, the —CO and —NH groups of nylon, the ester groups of polymethylmethacryalate and of polyvinyl acetate, the polar groups of polyvinylbutyral and the —CH groups of many adhesives quite possibly form bonds of this type with metal sur-

Fig. 10—Ionic Interactions Between Metal Oxide Surfaces

Note: A—"Ion-ion" interaction involving carboxyl group of polymethacrylic acid. B—"Ion-ion" interaction of a phenolic resin with metal oxide surface.

faces to some, as yet unknown, extent. The listing of adhesives here is not intended to be exhaustive.

E. van der Waals Bonding to metal surfaces—The adsorption data of Smith and co-workers *(33)* for n-nonadecanoic acid on platinum and gold surfaces are interpreted by them in terms of van der Waals interactions. Other metal and metal oxide surfaces bind the acid through much more powerful interactions. In metal and metal oxide systems, the oxygen appears to be much too ionic to give rise to pure van der Waals bonding.

There seem to be two ways in which van der Waals forces could contribute to the adhesion in these systems. First, they may contribute in part to other types of binding that have been discussed because the surfaces of the adherends and the polar groups of the adhesive consist of groups that have partial ionic character rather than of free ions.

Second, cancellation of the surface dipoles of a metal oxide would apparently leave only van der Waals interactions and charge transfer processes as the causes of the adhesion, if the cancellations were substantially complete. The less the ionic character of the surface and of the dipoles that interact with it, the more would one expect van der Waals forces to contribute to the total bonding energy.

The transition from a more ion-dipole type of surface interaction toward a more ion-ion type seems to be illustrated by results obtained by Koral, Ullman, and Eirich *(35)* who found that the adsorption of polyvinyl acetate on iron having an oxide coating was almost tripled when the polymer was hydrolyzed to the extent of about 13 per cent.

F. Bonding as a Result of Charge Transfer—It is established *(13)* *(20)* that there is a transfer of charge at a boundary between two different phases in contact, the adhesive-adherend boundary in the case of interest here. The amount of charge transfer is related to the work function of the metal surface and the electron affinity of the adhesive concerned.

Without discussing the mechanism of the transfer and the factors regulating the amount of charge involved, we may point out that this type of interaction probably is present in all cases of adhesion, to various degrees, of course, and a large part of the forces between two different phases could be due to it. The relative contribution of this effect to the total bonding force in adherend-adhesive systems has not yet been quantitatively evaluated.

Conclusions

Many of the types of bonds that could be responsible for the cohesive strengths of plastics and their adhesion to several different surfaces have been discussed. The present state of our knowledge makes it impossible to assign, in most cases, a definite interaction mechanism to a given adhesive-adherend system, though some of the factors favoring one bond type over another can, in many cases, be qualitatively described.

This situation does not justify the assumption sometimes made that when a postulated mechanism can be shown by approximate or refined calculations to be capable of supplying all or more than the observed strength of adhesion in a given system, the particular mechanism is the correct one. To establish the correctness of the mechanism it is required that proof be supplied either that other equally strong interactions cannot account for the phenomenon or that no other reasonable interaction can be so strong as the one postulated.

A virtue of a discussion, such as the present one, of adhesive-adherend interactions is that, by pointing out different basic causes of adhesion and some of the factors that may determine the types of bonds formed in a number of systems, bases are developed for the design of experiments the results of which will enable one more accurately to assess the relative roles of the various possible mechanisms. Difficult though it is, discriminating experiments can be designed that can supply many of the needed answers. Whether or not any or all of the types of bonds postulated here actually account for the observed cases of adhesion only time, during which much more experimental work is done and many more theoretical calculations made, can tell.

Acknowledgment

The author wishes to thank Professors M. E. Kenney and J. R. Shelton of Case Institute of Technology for valuable discussions and suggestions relative to the material presented here.

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High-Velocity Mixing of

Rug Backing Compounds

An improved method of producing compounds for conventional and foamed-in-place rug backing in greater volume and higher quality has been developed by Consolidated Latex Co., Chattanooga, Tenn. Key to the new technique is the use of high-speed impeller-type dissolvers to compound formulation ingredients.

Originally, Consolidated Latex considered using a battery of pebble mills to disperse the titanium dioxide and zinc oxide used in their coating compounds. However, this would have required the acquisition of propeller type mixers to disperse the clay in water and blend the pebble-milled slurries.

Drawing on his previous experience in the paint industry, William Stellings, president of Consolidated, decided that these separate steps could be combined by use of an impeller-type dissolver. In such a unit, direct mechanical action imparts extremely high velocity to the material, creating a zone of intense turbulence in the immediate area of the stainless steel impeller. The material is forced rapidly outward through itself.

As the high velocity material impinges on surrounding masses moving at a slower rate, "hydraulic attrition" takes place. This attrition is a combination of violent impact and shearing of particle against particle, and it multiplies the mechanical action of the impeller. The net result, Mr. Stellings reports, is a homogeneous product of excellent texture and stability.

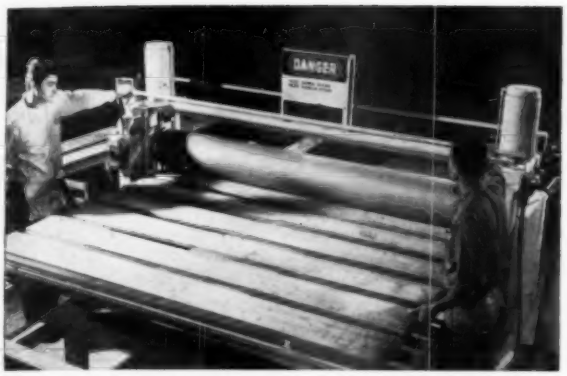
Consolidated Latex boasts a top-notch laboratory which has been set up and completely equipped for checking all phases of rug-backing manufacture. Formulations worked out to meet specific requirements are processed in a laboratory unit dissolver and application tests are made to determine adjustments necessary to assure proper qualities in the end product.

Laboratory mixer results are easily duplicated on the company's production model impeller-type dissolver. This is a 40-horsepower unit with a capacity of approximately 1500 gallons per hour of finished rug backing. The unit swings between two tanks into which materials are charged and processed alternately to permit continuous operation.

All of the dry materials in the rug backing—clay, titanium-dioxide, fillers, colors, etc.—are thoroughly dispersed to ultimate particle size in water and finally let down to the finished rug backing. The latter is then pumped into shipping drums or tank trucks.

The impeller-type dissolver, set up over two tanks to allow for continuous operation, produces 200,000 gallons of rug backing compound monthly.

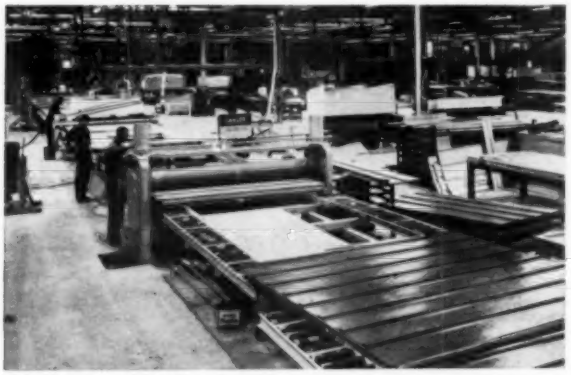
Note: The impeller-type dissolvers referred to in this article are marketed by Morehouse-Cowles, Inc., 1150 San Fernando Rd., Los Angeles 65, Calif., under the name of Cowles Dissolvers.



View of the infeed side of the rotary press at National Homes shows use of boards to apply pressure to the aluminum skins without deforming the regularly spaced ridges.

Improved glue spreaders, water-thinned contact cements, and rotary presses speed sandwich panel construction

Bonded Panels for Pre-Fab Construction



At the outfeed side of the 104-inch press, two strings of roller conveyor facilitate handling. A convenient working level is obtained by setting press in a shallow pit.

Industry observers have reported a tremendous growth in the use of adhesives in prefabricated housing and similar applications. Here, practice veers largely toward suitable laminating of dissimilar materials. Finished products range from relatively thin sandwich-type constructions to full-thickness panels used for exterior house walls.

The simplest form of structural sandwich involves the use of some type of core, or inner member, to which facings are adhesively bonded on both sides. Various types of adhesives have been used, but the contact cements have proved most popular for making up laminated assemblies from different types of materials.

Various manufacturing firms of substantial size have their entire operation based on the production of panels, doors and other flat building components which use honeycomb cores and various types of facings. Many times, a facing such as aluminum is preliminarily bonded to sheet vinyl or other plastics.

For a time, it was supposed that spraying was the only practical method of applying contact adhesives embodying fast-evaporating solvents. However, the industrial picture has been considerably altered by the development of mechanical glue spreaders designed to prevent adhesive thickening and spider-webbing caused by rapid solvent evaporation.

Special Spreaders

Some of the leading spreader manufacturers, such as Black Brothers, are offering special spreaders which are closely hooded-in to inhibit the evaporation of adhesive solvent. In addition, these spreaders are equipped with a series of solvent drippers arranged directly over the roll-crotch glue reservoirs. Sensitively adjustable, the drippers allow solvent to be added to the adhesive at precisely the rate of loss due to evaporation.

Another factor contributing toward wider use of the mechanical spreader is the development of water-thinned contact cements The latter completely eliminate problems of solvent evaporation. Where such glues are mechanically spread, all that is required is that rubber-covered resilient spreader rolls be grooved so as to lend themselves to efficient bondant spreading.

Whether adhesives are sprayed or mechanically spread, in more and more cases the combination of plies is obtained by means of a modern rotary press. Such presses are offered in a wide variety of widths, so that a suitable one is available for almost any particular application. Presses may be had with roll lengths as short as eight inches or as long as 104, 110, 116 inches or even larger.

At National Homes Corp., Lafayette, Ind., a 104-inch unit is used to glue aluminum sheets to the exterior

Note: The mechanical glue spreaders and rotary presses mentioned in this article are made by Black Bros. Co., Inc., Mendota, Ill.

sides of wall panels which are preliminarily framed to full thickness with 2x4's. To each side of the rough panels, ⅜-inch gypsum board is applied and the aluminum panels glued to the gypsum. The adhesive used is a Minnesota Mining and Mfg. Co. product particularly suitable for bonding aluminum to gypsum board.

To add strength and provide interesting vertical shadow lines, the aluminum sheets are first formed with parallel vertical ridges spaced a foot apart. The sheets are spray-painted and then baked in an oven before being bonded to the gypsum board on the outside surface of the wall panel.

In passing these large wall panels and applied aluminum sheets through the rotary press, it is necessary to transmit pressure from the top machine roll to the flat portions of the sheet which are glued to the gypsum. This must be done without the top machine roll encountering the ridges on the sheet.

To make this possible, uniformly thick boards of suitable length and width are used to cover the flat areas between the panel's ridges. Pressure exerted by the press' top roll is transmitted through the boards to the aluminum panel, pressing it tightly to the gypsum beneath. After a panel has been passed through the machine, the boards are removed and returned to the rotary press infeed, ready for use on the next panel.

To facilitate horizontal handling of these large and heavy wall panels through the wide rotary press, two strands of roller conveyor are arranged at the press infeed. Two similar runs of roller conveyor receive the panels at the outfeed.

Special facilities are provided at the job site for joining the wall panels together edge to edge by splining. In this way, a perfectly flush joint—and a perfect windbreak—is obtained.

Mechanical Laminators Come Clean

Anti-glue coating cuts "down time" in manufacturing bonded jewelery display materials

Use of a special releasing agent for gluing machines has provided a 15 to 20 per cent time saving in daily cleaning operations as well as a boost for employee morale at Display Novelties, Inc, New York City, manufacturer of display materials for jewelry shops.

Several years ago, increased production caused the firm to switch from hand laminating to machine gluing operations. Current production averages about 15,000 laminations per day, and this total rises to 25,000 during the company's six-month peak season. To keep all machines in top running order, daily cleanup of residual resin-base glues is essential.

Originally, the operation took about an hour and the task of removing messy, sticky glue from moving parts was looked forward to with no great enthusiasm by machine operators. To provide more efficient cleaning and reduce production-line down time, the company began coating these parts with a releasing agent incorporating a vegetable oil base.

Easily applied, this lubricant keeps glues and adhesive materials from clinging to rollers and other mechanical parts. All that is required is that a coat of the releasing agent be applied to all moving parts before the day's operations begin.

According to Michael Favia, plant manager at Display Novelties, the introduction of this practice has not only cut machine cleaning time significantly, but brought about improved employee cooperation in the important matter of production-line housekeeping. In addition, weekly maintenance checks on gluing units have shown a distinct improvement in machine condition.

For more than 20 years, Display Novelties has specialized in the manufacture of display units designed to show off jewelry pieces to their best advantage. One of the firm's most popular types of products is a "book display" made by laminating satin or velvet fabric to a hard cardboard base. These display units are used to line shelves and are placed on counter tops as a setting for jewels and other jewelry items.

Note: The releasing agent referred to in this article is produced under the trade name Release-Cote by Potdevin Machine Co., 285 North St., Teterboro, N.J.

A brush coating of the vegetable-base releasing agent prevents glue from sticking to the machine's moving parts.

Sodium Silicates:

Versatile Inorganic Adhesives

By ROBERT L. KREYLING
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The adhesive properties of liquid sodium silicates are useful in a great variety of bonding operations. As mineral, quick-setting adhesives, the silicates are ideal for combining and laminating paper, fiber board and asbestos products. Other important uses include the production of plywood, wall board and insulation products. This versatility is achieved in manufacture by varying the proportion of the ingredients of the sodium silicates, i.e., alkali and silica, and by special processing.

The liquid silicates range from slightly sticky fluids of the consistency of maple syrup to heavy viscous materials which barely flow and which have the plasticity of hot taffy. Products of relatively low alkalinity air dry readily.

While there are some cases in which highly alkaline silicates are used as adhesives, the usual limit for this purpose is a 47° Baumé silicate with a ratio of per cent alkali to per cent silica of 1:2.9. The average compositions of some commercial adhesive type sodium silicates are given in Table I.

The first step in silicate adhesion is the proper wetting of the surface. It is obvious that the bonding agent must establish very intimate contact with outer layers of the material to be joined. In other words, the adhesives must completely cover the area so that all the little irregularities are filled or bridged to provide interlocking hooks or keys that can grip the surface and hold it tightly. There is much more to adhesion than this, but it is clear that wetting is a basic requirement of a good adhesive bond.

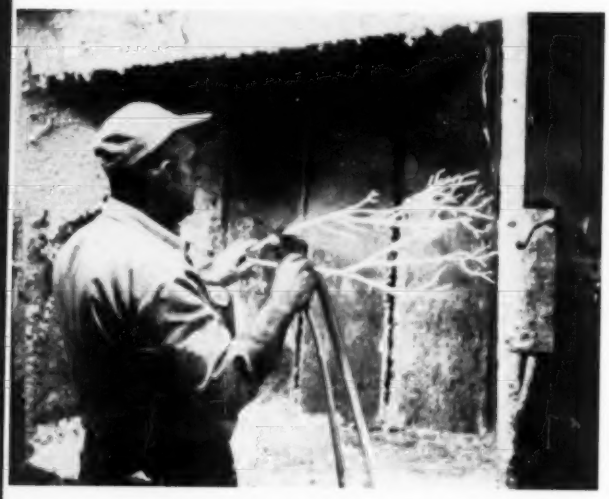
The wetting time of silicate adhesives is affected by viscosity and ratio. This is illustrated by experiments with #40 Whatman filter papers, showing variation in wetting according to the silicate product. The results are given in Figure I.

In many adhesive applications, setting time is a vital factor. Silicates set quickly through the loss of a small amount of water: (1) into the fibres or interces and (2) by evaporation into the air. In the manufacture of corrugated board for instance, a 42.2° Baumé silicate with a viscosity of 400 centipoises and 61.3 per cent of water will set when 14.7 per cent of water has been removed. Another silicate, used for corrugated board production, 39.7° Baumé with 330 centipoises and 63.4 per cent of water sets when only 13.5 per cent of water has been removed.

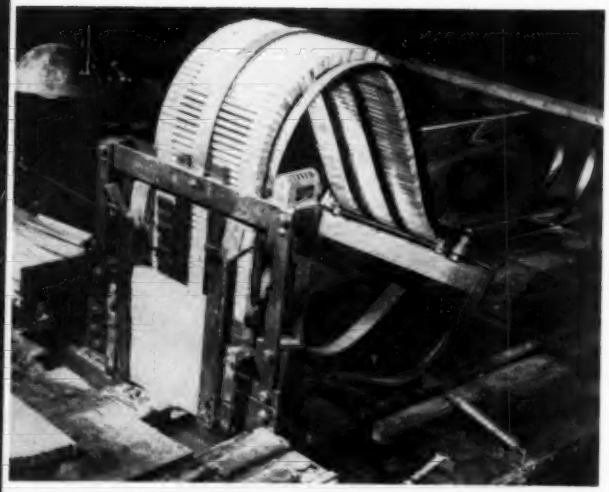
This difference does not seem very large, but the importance is evident when it is realized that for every ten pounds of the 42.2° Baumé silicate, 1.47 pounds of water must be evaporated from the glue line to provide a bond which permits slitting and scoring of the finished board at the take off of the machine. With the

Table I—Characteristics of Silicates of Soda Used as Adhesives

Per Cent Na_2O	*Per Cent SiO_2*	*Per Cent Na_2O:SiO_2 Wt. Ratio*	*°Baumé at 20° C.*	*Viscosity at 20° C. Poises*	*Uses*
11.0	31.9	1:2.9	47	9.6	Sealing cartons, shipping containers, metal foils, wall boards, flooring and trunk making
8.9	28.7	1:3.2	41	1.8	Corrugated paper board, flooring, paper tubes
9.2	29.5	1:3.2	42	4.0	Combined board, (wallboard) plywood
8.3	28.2	1:3.4	39.7	3.3	Corrugated paper board
6.7	25.3	1:3.7	35.0	2.2	Special uses



Branches, wreaths of conifers and other Christmas ornaments are coated with sodium silicate adhesive to hold the flocked material.



The application of sodium silicate adhesive to the ends of these wooden strips permits the adherence of felt strips.

On this tube winding production line, sodium silicate adhesives are used to produce tubes of up to 24 inches in diameter.

39.7° Baumé silicate, a loss of 1.35 pounds of water for ten pounds of silicate is sufficient. That difference of only 0.12 pound may result in a better bond with a ten per cent or even greater increase in machine speed.

Wetting by silicate adhesives of highly sized papers, metals and other materials on which silicate does not spread well is often improved by the addition of surface active agents. Poor wetting of metals by silicate adhesive may be due to dirt, grease or absorbed gas film, and these must first be removed.

Up to two per cent of sulfonated caster oil, oleic or fatty acids, bile acids, saponin, rosin soaps, naphthalenesulfonic acids, sulfates of aliphatic compounds containing more than seven carbon atoms have been used as surface active agents.

Due to residual carbonaceous material from the rolling operation, aluminum foil surfaces may present some resistance to wetting by the silicate adhesive. The addition of 1/10 per cent wetting agent, such as Nacconol (made by National Aniline Division of Allied Chemical Corp.) overcomes this resistance, and aluminum foil is successfully laminated to paper backing.

Silicate Bond Strength

The ultimate strength of the silicate bond is very high. Silicate films provide tensile strengths of 1000 psi which are more than sufficient to grip the materials ordinarly combined. In an experiment, a silicate bond used to adhere walnut wood blocks exhibited a strength of 400 to 700 pounds per square inch after drying for 28 days.

Silicate adhesives contribute greatly to the rigidity of boxboard and to spiral tubes. In paper tubes the silicate film becomes a "hidden ply," serving in many instances as a barrier that prevents the transfer of oil and water vapor.

Generally, the silicates are used as received but various modifications of a silicate adhesive film are possible and frequently distinctly useful. If a straight silicate sets too fast for a particular operation the addition of water, even in small quantities, will delay the setting time. However, the viscosity is thus reduced resulting in increased penetration.

The use of finely divided mineral matters overcomes this objection by restoring the viscosity and keeping the inherently more fluid film where it is wanted until setting takes place.

Hydrous clays are the most useful additions for this purpose.

Although not completely waterproof, silicate bonds show considerable resistance to moisture. Water resistance may be improved by adding small quantities of reactive materials shortly before use. The choice of material is limited to those which react slowly in the cold such as zinc oxide, calcium carbonate or some forms of magnesium oxide. Such reactions are facilitated by warming the film after it is in place.

The flexibility of films of silicate adhesives may be improved by the addition of a small amount of plasticizers that are compatible with sodium solution; for example, ordinary cane sugar, molasses, invert sugars, starch, water soluble gums, glycerine, sodium alginate, rubber latex, sorbitol and most other polyhydroxy derivitives are effective.

Adhesives Mixtures

Adhesives composed of mixtures of sodium silicates with starches, dextrine, glues, casein, blood, gum arabic and other water-soluble gums, borax, soy-bean meal, rosin and rubber latex have been known and used for many years. Sometimes mixtures may even be more satisfactory than any one of the materials used alone.

Thus, the addition of silicate to a water-resistant adhesive of casein or vegetable protein and lime increases working life and lowers cost. For wood veneers, 41° and 42° Baumé silicates (1:3.2 ratio) are widely used. High grade plywood for interior decoration is made from combinations of 41° Baumé silicate, casein, lime and special protein mixtures.

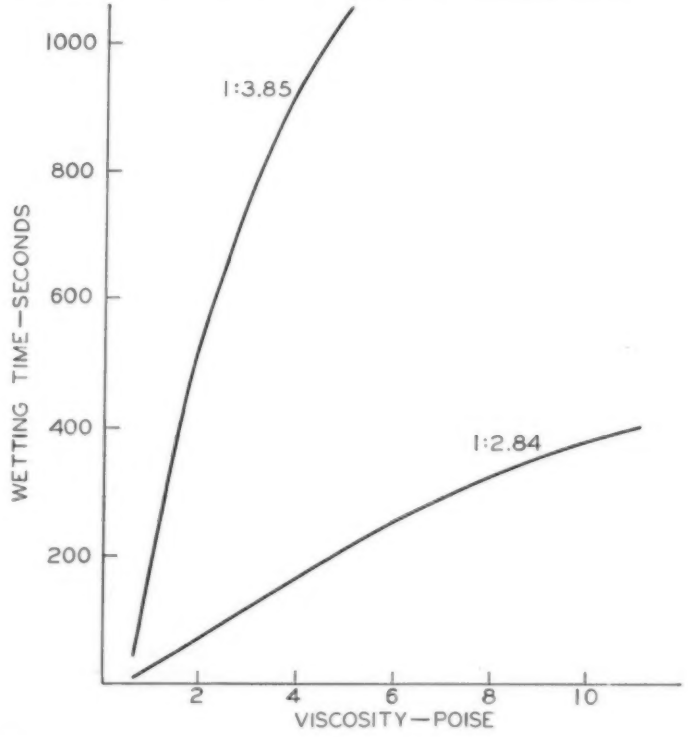
The bond so formed is not intended for exterior exposure, but it does show remarkably high resistance to delamination on soaking. Such plywood is widely adapted for cabinets, furniture, wall paneling and similar interior service.

Compatibility

Soluble silicates are partially compatible with aqueous emulsions of various types of organic synthetic resins. Patent literature includes combinations with polyvinyl acetate and its modifications, dimethylol urea and similar urea-formaldehyde condensation products, polyesters, polyamides, silicones and polytetrafluoroethylene. Such mixtures are claimed to exhibit improved water resistance over straight silicate films, permitting curing at considerably lower temperature. At the same time, the inorganic silicate imparts greater fire resistance to the resins and lowers adhesive costs.

From the earliest use in the manufacture of boxboard and for sealing box flaps to present day applications, silicate adhesives satisfy the needs of dozens of industries. Patent literature offers evidence of continuing interest in sodium silicate to fill industry's requirements for an efficient, low cost adhesive.

Figure 1—Relationship of Wetting Time for No. 40 Whatman Filter Paper to Viscosity and Ratio of Sodium Silicate Adhesives



Note: Per cent Na_2O: per cent SiO_2 ratios of 1:3.85 and 1:2.84 are shown.

About the Author . . .

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How to Protect

Stainless Steel Curtain Wall Panels

By R. BLICKENSDERFER
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Builders have long had the problem of turning over to owners materials in the finished exterior of the building that looked as presentable as they did when delivered to the contractor by the fabricator. This has been true of brick, stone, marble, glass, porcelain enamel, aluminum, stainless steel—in fact, any material whose finished surface was produced off site. Surface protection is justified when is costs less than restoration.

Like any other material, stainless steel curtain wall panels should be protected against normal construction hazards. Various types of masking materials are often used for this purpose. One of the problems is what type of masking material to use.

What It Has To Do

A satisfactory masking material must fully protect stainless steel curtain wall panels during shipment; during storage at the building site; during erection of the curtain wall; and after erection of the curtain wall but before the building is completed.

A suitable masking material must not only protect the metal from normal hazards through these stages, but must also have certain other desirable properties. These should include:

(1) A useful life of one to two years.

(2) Easy removal of the masking material, even after prolonged periods of bold outdoor exposure.

(3) Complete removal, which means it should not be necessary to clean the building after removing the protective mask—a time-taking and costly procedure.

(4) Inability to absorb water.

(5) Easy application. This includes such advantages as speed, no drying operations, no special equipment, no highly skilled labor.

(6) Applicability to smooth surfaces, textured surfaces, and to panels with formed designs (such as in the Socony building).

(7) Moderate cost.

(8) Good solar heat reflectivity. For example, a black or other dark colored masking material could easily become too hot to handle comfortably on the job.

The basic types of masking materials currently available are:

(1) Strippable films.

(2) Pressure sensitive tapes.

(3) Waxes.

Protective Values of Masking Material

Properties	Pressure Sensitive Tapes Paper or Plastic Film: Reflective Backing, Solvent Type Adhesive	Reflective Backing, Water Soluble Adhesive	Non-Reflective Backing, Solvent Type Adhesive	Non-Reflective Backing, Water Soluble Adhesive	Strippable Film	Wax
Ease of removal (initially)	1	1	1	1	1–2	3
(After 1 year of outside exposure)	1	1	2–3	2–3	2–3	3
Leaves no objectionable residue	2–3	1	2–3	1	2	3
Won't absorb water	1	1	1–3	1–3	1	2
Withstand rubbing	1	1	1–3	1–3	1	2
Withstand scratches	1	1	1–3	1–3	1–3	3
Withstand oil, grease, etc.	1	1	1–3	1–3	1	3
Withstand acids	1	1	1–3	1–3	1	2
Withstand mortar, concrete	1	1	1	1	1	3
Withstand putty, caulk, etc.	1	1	1	1	1	3
Withstand weld splatter	1	1	1–2	1–2	1–3	?
Fire (safe)	1	1	1–3	1–3	1	3
Protects against dust, smog	1	1	1	1	1	1
Protects against rain stains	1	1	1	1	1	1
Stay in place (1 year or more)	1	1	1–3	1–3	1	1–3
Stays cool in sun	1	1	1–3	1–3	2–3	2
Application						
Precleaning stainless steel to remove oil, etc.	1	1	1	1	2	2
Material cost	3	3	2	2	3	1
Unskilled labor	1	1	1	1	2	1
Minimum facilities	1	1	1	1	2	1
Minimum time	1	1	1	1	2	1
Quality at application	1	1	1	1	2	2
Toxic fumes during application	1	1	1	1	3	1
Applicable to textured surfaces	2	2	2	2	1	1
Applicable to formed surfaces	2–3	2–3	2–3	2–3	1	1

Note: The following values were assigned to ratings: 1—best; 2—medium; and 3—poorest.

STAFF REPORT

High-Speed Bookbinding

A step-by-step guide to adhesive operations from folded signatures to the bound book

Operating right in the heart of New York, the book binderies set up to serve the city's vast publishing industry are among the metropolitan area's most important, large-scale users of adhesives. One of the biggest of these, American Book-Stratford Press, Inc., turns out approximately 100,000 finished books a day for top flight houses such as Simon and Schuster, Lippincott, Holt, Harper Bros. and Prentice Hall.

An examination of operations at American Book can serve as a general guide to how adhesive products and equipment are employed in the bindery industry. Essentially, adhesives come into play five times during the manufacture of a bound book: end sheet application, gluing off, backlining, case making and casing-in. Each of these operations is highly mechanized and is handled at speeds that would have been thought impossible only 25 years ago.

Once the sheets received from the printing presses have been folded into sections or signatures—generally of 16 or 32 pages—a book is ready for the actual binding operation. The first step in this process is the application of end sheets to the book's first and last signatures.

Placed in a hopper, these signatures are automatically fed to an applicator which uses a starch paste to tip on a four-page section of a strong paper. The outer leaves of these end sections will eventually be lined up with and pasted to the book's case or cover; the inner pages of the end section will form the book's fly leaves.

To assure smooth functioning of the end leaf applicator, a box of pumice powder is kept near at hand to dust off the machinery after any accidental spillage.

Gathering Signatures

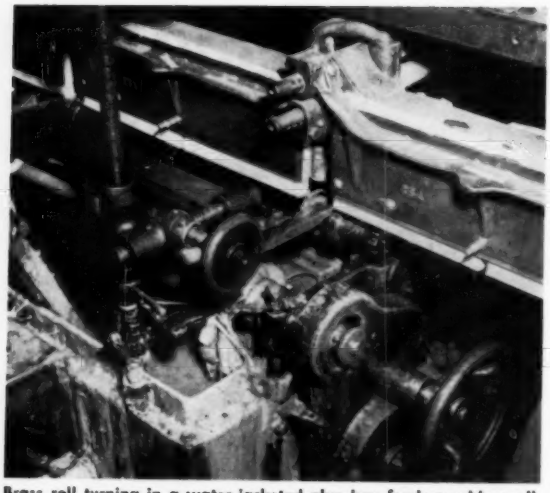
Before the next adhesive step, all signatures of a book must be gathered in sequence and sewn. Running at normal speeds, the automatic Sheridan Gatherer can collate from 700 to 900 signatures a minute. For special jobs, the machine can be changed so that two books can be gathered at one time. This means from approximately 1000 to 1500 signatures per minute. Units such as the Sheridan Juengst Gatherer will automatically detect missing inserts or duplicates.

Gathered and sewn books then are ready to be "smashed" into shape, This is done in special presses which can apply 250 tons of pressure to reduce the book's bulk and back swelling.

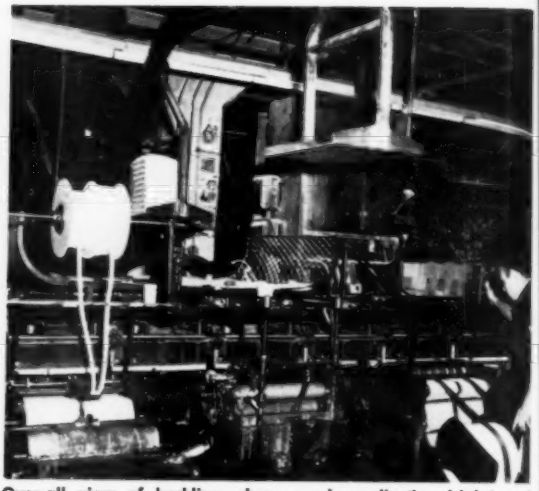
After smashing, gathered books proceed to the gluing off operation. Here books are automatically run over an applicator and hot flexible hide glue is forced approximately 1/32-inch between signatures. This operation is extremely important as faulty gluing here will eventually lead to "breaks"—separations between signatures of a bound volume —and "starts"—signatures presenting an uneven appearance on the front edge of a bound book. Gluing off not only keeps the sewn threads firmly in place, but will hold the book itself together during later backing steps.

End sections of four pages are automatically tipped to the first and last signatures of a book to be bound.

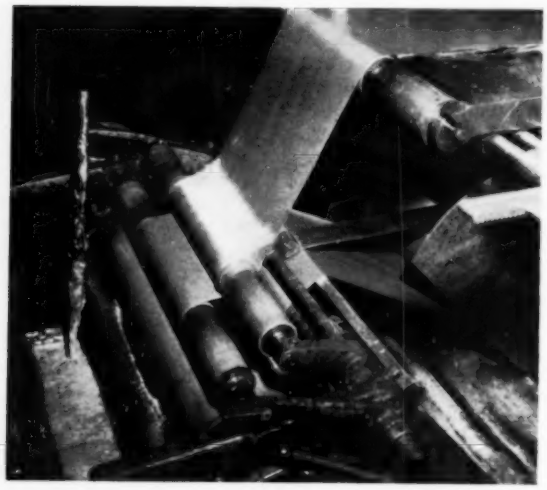
In the gluing off operation, a 1/32-inch penetration of glue is forced between the signatures of a sewn book.



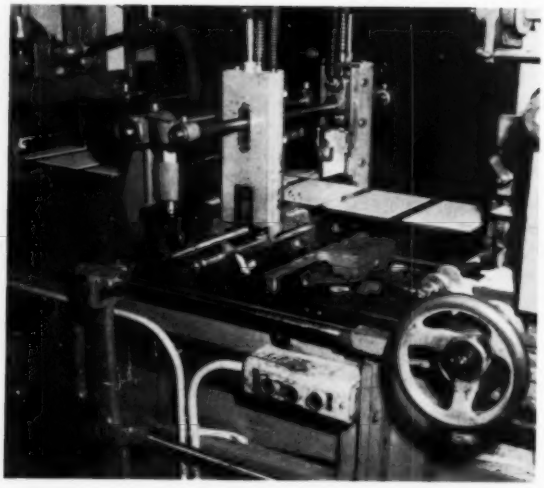
Brass roll turning in a water-jacketed glue box feeds a rubber roll which spreads glue on book's backbone.



Over-all view of backliner shows crash application (right) and liner-headband feed (left). Note overhead conveyors.



Roll of cover fabric is fed through glue rolls which cover the underside with bone glue. From 30-45 cases a minute are produced.



The cover boards are placed on the glued cloth from a hopper feed. Cloth measuring and board spacing are completely automatic.

Before moving on to the backing operation, however, books are placed in an automatic trimmer which shaves the top, bottom and leading edge of each in a single movement. Then in rounding and backing, books which have been gathered, sewn, smashed, glued off and trimmed are shaped into round and jointed for the eventual application of the cover.

Flat-backed glued-off books are placed vertically—backs down—into a hopper which feeds them into clamps that carry them to the nipping station. Here powerful toggle-actuated jaws nip the backs of the books to a uniform thickness. The books are then automatically advanced to the initial rounding.

In initial rounding an overhead "pusher" shoves the books firmly against a "former" at the bottom. A clamp then carries the books to the main former. Here they are pulled down to the desired round by means of rollers on each side. Operating in unison, the rollers squeeze the books, pulling them down and accentuating the round.

The next procedure, backing, is done in two steps. In the first operation, a backing iron passes over the book backs and forms a partial joint. At the next station, the required pressure on the backbone completes the joints—hinges where the cover boards of a book stop. Books are backed from the center out and each signature has the same uniform round.

The rounded and backed books are now ready for the next adhesive step: application of "crash"

cloth, lining paper and decorative headbands to the backbone of the book. This operation is known as backlining.

As the books move down the backliner machine, hot animal glue fed from a water-jacketed glue box is distributed from a brass roll, to a rubber roll, to the book's backbone. After the first glue application, crash cloth—an open-weave starched cotton—is applied. The crash is fed from rolls of desired widths and is automatically cut to exact length before being mechanically applied to the glue-spread book.

The books then pass to another glue box station where they receive an additional adhesive application. After this step, lining paper is automatically dispensed, cut to size and applied to the glued backbone. At this point, decorative headbands may be affixed to the top and bottom of each book.

The mechanical headbanding device is set up to handle headbands made up in rolls wound left and right. Small glue transfer rollers revolve in a glue box and apply narrow strips of adhesive to the outer edges of the lining paper. The headbands feed simultaneously with the paper and are accurately applied to it in the required widths before the paper is cut and applied to the books.

Double Crash Work

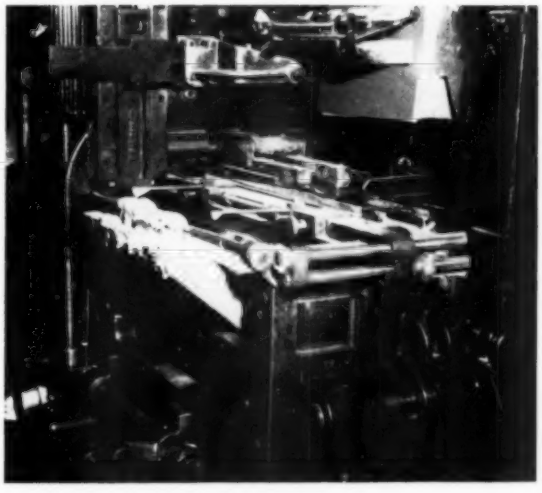
Some books require double crash work. In such cases, backlining equipment with an additional glue application station is used.

Before proceeding to case making and casing-in equipment, backlined books are advanced to a series of rubbing down devices. First, a rubber blanket running through water presses the books evenly without disturbing the signature alignment. The books then pass over a pneumatic rubber roll, also running in water, which firmly presses down the crash, paper and headband. In a final step, the books pass over a series of special spools which assure that the crash, paper and headbands are firmly affixed.

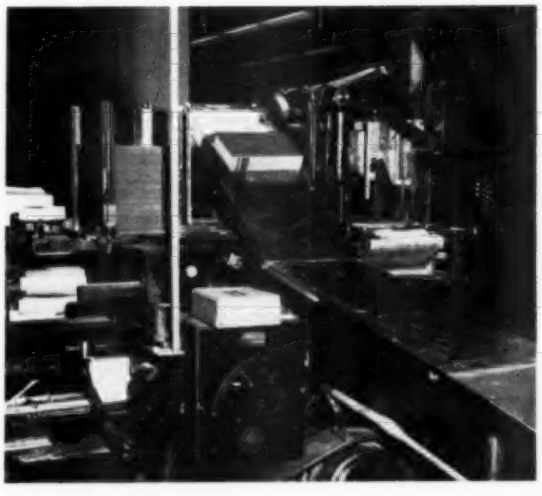
At American Book, finished backlined books are placed on small overhead conveying platforms and brought to the case making and casing-in equipment.

A "case" is the industry term for a completed cover ready to be affixed to the book. It consists of the covering fabric, front and back boards, and a strip of lining paper for the backbone. In "casing-in," paste or

At the completion of the backlining operation, books are fed into the bottom of a semi-automatic casing-in machine.



Moving through the unit in an upward direction, the book with paste-spread end pages is fitted into the cover.



Completely bound book, a copy of Pasternak's "Dr. Zhivago," slides down the chute of the casing-in unit.

glue is applied to the end papers of a book which is then inserted into the case or cover. The case has generally been previously stamped with title, author and publisher information.

In the Sheridan Casemaker equipment used at American Book, the covering cloth is fed from a continuous roll and a coating of bone glue applied to the underside. As the cloth moves through the unit, cover boards are automatically dropped onto it from a hopper feed. The cloth extends approximately half an inch on all sides of the boards.

As the cloth and boards proceed through the casemaker, a corner cutter mechanism shapes the cloth to allow for neat corners. The excess cloth is then folded over the boards on two sides and the cases automatically cut apart. At this point, turn-in rolls fold over the remaining two sides of the covering cloth.

Back linings for the case are automatically fed from a continuous roll. A movable knife cuts off the exact width required. During the cutting, a pneumatic device grips the strip and does not release it until it has been placed on the glued cloth.

In a finishing operation, the completed case is run through rollers to remove any possible wrinkles and blisters. After being allowed to dry for several hours, the cover can then be stamped, if desired.

Completing the Operation

Casing-in completes the book binding operation. The semi-automatic equipment used here works on a rotary principle. Books arriving from the backlining department are hand-fed into the bottom of the unit and proceed in a continuous upward movement. First an application of starch paste is picked up on the end pages of the book. The latter then meets with a case being automatically fed from a hopper and passes between a set of rollers. The completely cased-in book is then deposited on a chute and slides into the hands of a waiting operator.

"Wet" books may receive an automatic hinge-reinforcing operation or be placed between wooden boards lined with metal in 1/16-inch relief. When a stack is built up, pressure is applied to "groove" the books by holding them firmly until they dry.

Note: The Sheridan bookbinding equipment described here is manufactured by T. W. & C. B. Sheridan Co., 401 Broadway, New York, New York.

Glossary of Bookbinding Terms Used in this Article

Back-Lining—Crash, paper, or other material used to strengthen book backs after the rounding and backing operations.

Breaks—Separations between the signatures of a backed or bound volume. This is often caused by improper gluing.

Case Making—Production of the finished cover by automatically cutting cover fabric and gluing it to the boards used for stiffening.

Casing-In—Application of paste or glue to the end signatures of a book and insertion of the book into its case.

Crash—A coarse, open weave starched cotton used to reinforce the back of a book. Also known as super.

End Papers—Signatures of four or eight blank pages tipped to the beginning and end of a book. One page at either end is pasted against the cover, the others act as fly leafs.

Gluing Off—Applying glue to the back of a gathered and sewn book. The penetration of glue between signatures holds them in place.

Grooving—Pressing a cased-in book between metal-bound boards to produce the channels which run parallel to the backbone joints.

Rounding—Mechanical shaping of a flat-backed, glued-off book into round by means of rollers on either side of the book.

Smashing—The use of special presses to reduce the bulk and back swelling of a book.

Starts—Signatures which present an uneven appearance on the front edge of a trimmed book.

NEWS of the
ADHESIVES WORLD

4th Annual Design Engineering Show Features Unique Adhesive Applications

Over 18,000 visitors from 15 nations attended the 4th Annual Design Engineering Show on May 25-28, at Convention Hall in Philadelphia, Penna. The show, produced by Clapp & Poliak, New York, N.Y., was held concurrently with the Design Engineering Conference and was sponsored by the Machine Design Division of the American Society of Mechanical Engineers. The show was devoted to "Research and Development in Industry," and 401 companies participated with exhibits.

Technical experts from these companies gave advice, answered questions, demonstrated new materials and processes, distributed technical data, supplied samples of new products, and conducted performance tests. The exhibits were arranged to provide maximum interest and value to those attending. The exhibit groupings were Fasteners and Adhesives; Finishes and Coatings; Non-Metallic Materials; Metallic Materials; Forms and Shapes; Mechanical, Electrical Electronic and Hydraulic Components; and Research, Testing and other services for Product Development.

Adhesives Exhibits

There were a number of exhibits of interest to the adhesives industry. The exhibit of the American Sealants Co., Hartford, Conn., featured a new design engineer's kit No. 10-10, which contained ten grades of Loctite sealant. The kit is aimed to assist the designer in determining the proper grade of Loctite during the design stages of product development and for general experimental work. According to the company, Loctite is a thin liquid that hardens between closely fitting metal parts, and forms a tough heat and oil resistant bond that secures threaded parts.

The Industrial Division of Armstrong Cork Co., Lancaster, Penna., displayed adhesives, gaskets, vibration damping felts, friction materials, cast urethane, and asbestos products. In the adhesives exhibit, Armstrong demonstrated the effectiveness of the new Eastman 910, which it distributes, by bonding samples on the spot. Among products shown for the first time by Armstrong were a new vibration damping material, designated No. 881-658FF, and a new cork and silicone rubber material, called LC-800, for high temperature sealing.

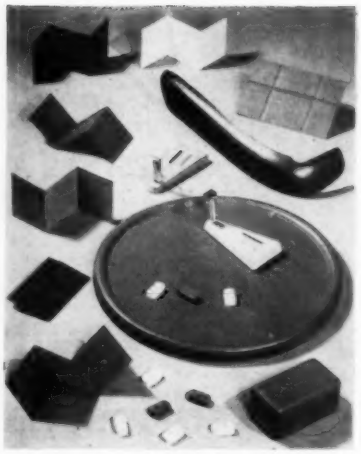
A new non-staining finish for its Colovin laminate quality vinyl sheeting was exhibited by the Columbus Coated Fabrics Corp., Columbus, Ohio. It was shown that this vinyl sheeting can be laminated to steel, aluminum and other metals.

Dobeckmun Co., a division of Dow Chemical Co., Cleveland, Ohio, displayed a model of an air-supported building which was constructed with a special polyethylene film lamination developed by Dobeckmun for air-supported structures. The company also demonstrated a number of other new product applications including a polyethylene-Mylar lamination.

Eastman 910 Adhesive being publicly demonstrated for the first time at Eastman Chemical Products' "do-it-yourself" exhibit at the Design Engineering Show.

DuPont's exhibit, built around six different films, covered a broad property spectrum and emphasized the versatile and increasingly important role of films in industry. Teslar PVF film was shown for the first time. Its outstanding weatherability, toughness, chemical resistance and thermoformability was shown. A new pigmented form, designed for use as a decorative as well as protective coating on wood and metal building materials, was announced, and laminations of the film to metal by commercial processes which develop bonds stronger than the film itself were exhibited.

Other films on display included Mylar polyester, Teflon, polyethylene, acetate and cellophane. It was shown that a major industrial use for cellophane is in pressure-sensitive tapes, while acetate applications included magnetic tape base and lamination to printed surfaces to improve appearance and protection.



The versatility of United States Steel's new vinyl coated steel as a design metal is shown by the variety of parts . . . a highlight of the USS display at the Design Engineering Show.

Do-It-Yourself Display

Eastman Chemical Products, Inc., Kingsport, Tenn., featured a "do-it-yourself" display which publicly demonstrated, for the first time, the bonding ability of Eastman 910 Adhesive. Visitors to the booth conducted their own bonding experiments with 910 Adhesive, bonding together numerous combinations of materials. Also demonstrated by Eastman Chemical was a newly developed technique that gives high relief to flat extruded sheet of Tenite butyrate. The technique shown imparts a rich, sparkling surface texture to the tough, weather-resistant plastic.

One of the newest applications of versatile fiberglass was exhibited by Johns-Manville, New York, N.Y. Shown was a molded fiberglass "headliner" for automobile interiors. The laminated headliner combines fiberglass with vinyl film or cloth trim, and was shown to give a neat yet luxurious appearance to the car's interior. Three other major lines of fiberglass were also exhibited . . . textile yarn, roving and micro-fibers.

A wide variety of adhesives, sealers and reinforced plastics that permit new design concepts were featured at the exhibit of the Minnesota Mining and Manufacturing Co., St. Paul, Minn. Among the products shown were 3M's new high strength Scotchweld Brand bonding film adhesives for metal-to-metal bonding; composite film adhesives for honeycomb sandwich construction; high heat resistant and high strength structural adhesives; water dispersed contact bond adhesives for bonding decorative laminates and sandwich panel construction; and heat expandable liquid sealers for positive sealing in any type opening and in areas where pressure cannot be applied. In addition, various metal-to-metal assemblies, such as rotor blades, castings and tubing which are joined with the new structural adhesives were displayed to illustrate this new assembly design technique.

Mobay Chemical Co., Pittsburgh, Penna., displayed a number of new product applications for urethane materials, consisting of both flexible and rigid foams, elastomers, and protective coatings. The firm showed a wide assortment of fabricated gears, bushings, shock mounts, drive belts, cushioning and insulating components, seat cushion designs, scientific instrument containers, aircraft and missile components and urethane-coated metal, wood, concrete, leather and rubber products, providing complete engineering data on properties for the various urethane-based materials.

Permacel, New Brunswick, N.J., featured several new products as the highlight of its display. The products included Permacel Ribbon Dope Thread Sealant, several new epoxy resin systems, electrical tapes, and a heater element sandwich material. Ribbon Dope Thread Sealant is said to be a completely new kind of pipe dope with qualities superior to any other method of pipe joint sealing. The epoxy resins shown were Permacel PRH 400 and PRH 401. PRH 400 is a solvent based epoxy system recommended for use as a protective coating for printed circuits and other electrical and electronic components. It can also be used for surface coating of plastics, ceramics, concrete and to protect metallic materials from rust and corrosion. PRH 401 is a single component system. It is a fluid, heat-curing, solvent-based epoxy system recommended for use in adhesive for metals; impregnating of coils; manufacture of stators and rotors; and dry lay-up applications of glass cloth.

The electrical tapes show were Permacel 422 Teflon Film Tape and Permacel 426 Electrical Grade Rayon Reinforced Film Tape. Permacel 422 is a pressure-sensitive tape and has a silicone adhesive which together with its backing gives it excellent electrical, physical and chemical characteristics. Another feature of Permacel's exhibit was the display of the company's complete line of pressure-sensitive, water based and solvent based adhesives.

Flame-Retardant Laminates

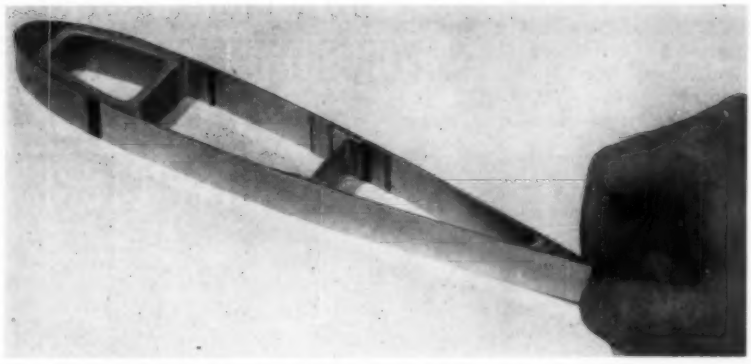
New flame-retardant laminates were featured in the complete line of industrial thermosetting laminated plastics exhibited by Synthane Corp., Oaks, Penna. In addition to laminates with specially-developed flame-retardant characteristics, Synthane showed other products of interest to design engineers, including laminated sheets, rods, and tubes, as well as its full line of copper-clad laminates for printed circuitry. The flame-retardant laminates shown were grades FR-1, FR-2, and EP-22. They are paper-based laminated plastics with phenolic resin binders which possess the general characteristics of hard paper-based laminates. Their excellent flame-retardant and self-extinguishing properties, plus the usual high dielectric strength and resistance to moisture make them well-suited for many special electrical applications, as was shown at the exhibit.

Samples of more than 100 uses of plastics were displayed by Union Carbide Plastics Co., Division of Union Carbide Corp., New York, N.Y. They ranged from football nose guards made of high-density polyethylene to epoxy-impregnated printed circuits used in missile guidance systems. A special section of the exhibit was set aside for the showing of a motion picture which demonstrated a new epoxy spray gun technique for building boats and other vessels from a mixture of chopped

glass fibers and 100 per cent reactive liquid epoxy resins. One of the products displayed was a 12½-foot pleasure boat made in three hours by the new technique.

Applications of the other major plastics produced by the company . . . phenolics, styrene, polyethylene, and vinyl . . . were also featured. Products exhibited in the styrene and phenolic areas included large sized plastic moldings. A special display showed metalized cast vinyl film developed for use in the packaging field. A variety of polyethylene applications, of high-density and low-density materials, also was shown.

United States Steel Corp., Pittsburgh, Penna., exhibited for the first time in public its newest product, vinyl coated steel. The colorful new steel can be used in fabrications ranging from flat work to deep drawing, and requires little or no post-fabricating processing beyond cleaning. According to the company, USS vinyl coated steel represents one of the newest design materials and already is being used in appliance and office equipment industries, as well as in building and railroad car interiors. Examples of the vinyl coated steel were displayed and it was shown that it can be embossed with any texture that can be engraved on a printing roll, and it can be produced in any specific color with assurance of color uniformity.



Featured at the Design Engineering Show by Minnesota, Mining and Manufacturing Co. was its new Scotchweld Brand bonding film adhesive (dark areas) shown bonding supporting members and leading and trailing edges of helicopter rotor blades.

Taylor Fibre Co. Norristown, Penna., displayed a new paper-base epoxy laminate, a fire-retardant laminate and a surface finish for copper-clad laminates. Photographs showing various applications of laminated plastics and vulcanized fiber were displayed in the Taylor booth. Also shown were parts illustrating different fabricating techniques. Basic materials on exhibit included phenolic, melamine, silicone, epoxy and copper-clad laminated plastics and commercial, bone, and electrical insulation grades vulcanized fiber. Fabricated parts of many different types were also exhibited.

The Design Engineering Conference, which ran concurrently with the show, covered in detail such subjects as latest developments in plastics, metals and ceramics for high temperature service; materials to resist corrosion; and the mechanical, power and control aspects of design engineering. In addition to the technical sessions, the conference had two general sessions—one devoted to engineering design in Germany, and the other on general design engineering problems and the effective use of engineers.

Staley Enters New Field

A. E. Staley Manufacturing Co., Decatur, Ill., is entering the synthetic polymer field as part of a stepped up research and diversification program which was launched three years ago. A polymer pilot plant was put in operation at Decatur early this year and is now in semi-works production of acrylic type emulsions. The company also plans to acquire the U B S Chemical Corp. of Cambridge, Mass. Acquisition of the chemical concern, subject to approval of U B S stockholders, will add that company's chemical plant and laboratories at Cambridge; a new polymer plant put into operation recently at Lemont, Ill.; a polymer plant and laboratory currently under construction at Marlboro, Mass.; a technical laboratory near Greenville, S. C.; and other U B S facilities. A Staley spokesman stated that entry into the polymer field is a logical extension of the company's traditional interest in natural polymer products derived from corn and soybeans.

SPE Reviews New Text

An elementary textbook on foam plastics, which is expected to be used by ordnance design engineers, is now under review by the Plastics Activities Group on Plastics in Building of the Society of Plastics Engineers and members of its subordinate committee at the Newark section. Ronald J. Carney, PAG chairman and Vincent Sussman of the Newark section are supervising the task of checking the text for accuracy and completeness. The book was written by William Tanner of the Plastics and Adhesives Research Section of Picatinny Arsenal, N. J.

Papercraft Buys Unit

Papercraft Corp., Pittsburgh, Penna., has acquired a pressure-sensitive tape plant facility located in Passaic, N. J., from the U.S. Rubber Co. Purchase was made for cash, but the price has not been disclosed. The company plans to move the Passaic plant to its Jeannette, Penna., facility.

Review Binding Methods

Three organizations are sponsoring proposed revisions in the "Official Minimum Manufacturing Standards and Specifications for Textbooks," which, it is believed, will permit book manufacturers greater freedom in the use of compatible synthetic adhesives for binding and casing operations. Sponsored by the Book Manufacturers' Institute, Inc., the National Association of Textbook Directors and the American Textbook Publishers Institute, the revised specifications are now being considered by various state agencies on textbook binding standards.

Malcolm H. Frost, general counselor and executive director of the Book Manufacturers' Institute, said a committee of adhesives manufacturers is now being formed to serve in an advisory capacity to the organizations sponsoring the changes and to help set up adhesives specifications for the book industry. Those interested in serving on the committee should write to Mr. Frost at the BMI, 25 W. 43rd St., New York 36, N. Y.

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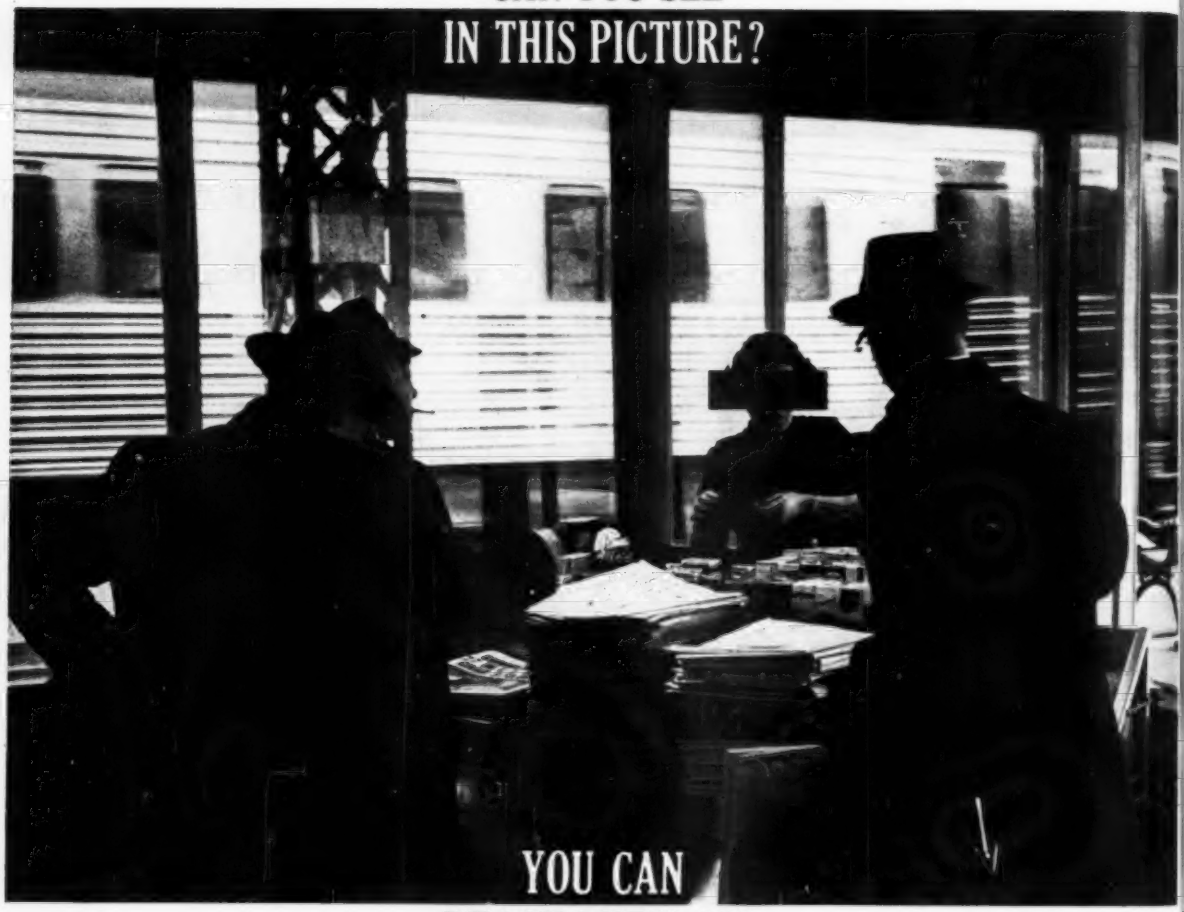

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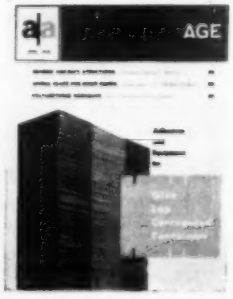

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Form Consultant Firm

Dr. Eugene W. K. Schwarz and Henry C. Speel have announced the formation of Schwarz, Speel and Associates, textile and chemical consultants, with offices at 101 West 31st Street, New York, N.Y. The firm is affiliated with Skeist and Schwarz Laboratories, Newark, N.J. Associate consultants include Dr. Irving Skeist, polymer chemist; Harold E. Bode, chemical economist; and Preston R. Smith, chemical engineering specialist on asphalt and tar products.

Dr. Schwarz reports that the new organization was established to more efficiently serve the needs of clients in today's increasingly more complex textile and chemical technology. He states that it is becoming more difficult for the individual consultant to keep pace with the many new developments taking place except as regards the continually narrowing limits of his specialty. At the same time, the requirements of business and industrial clients demand an increasingly broader range of technical know-how which can best be supplied by an organization of consultants, he said. According to Dr. Schwarz, the organization is engaged in product development and marketing services with special emphasis on fiber development and textile dyeing and processing technology.

Offers Custom Service

Polytex Adhesives Corp., Wallington, N.J., has announced that it is making available a custom solutioning service for rubber and resin based compounds. M. P. Schester, president of Polytex, states that with modern rubber milling and dissolving equipment, Polytex is processing rubber and resin based solutions in volatile solvents for adhesive companies lacking facilities for handling volatile or flammable solvents. According to Mr. Schester, the heavy duty equipment used makes it possible to process high solids and high viscosity materials not manageable by ordinary equipment.

Carton Volume Up

Folding Paper Box Association of America, Chicago, Ill., reports that dollar volume of folding carton shipments for March, 1959, rose to $79,500,000, an increase of 5.5 per cent over the same period of 1958. The industry output totaled 203,830 tons, up 6.6 per cent. First quarter business was ahead of the same period last year, 1.5 per cent in dollar value and 1.4 per cent in tonnage.

Non-Skid Paper

Armour Research Foundation of the Illinois Institute of Technology, Chicago, Ill., has announced that it has developed a new, economical, non-skid paper surface which promises to solve many problems confronting industries and businesses using or handling paper bags. Developed for Cromwell Paper Co., the non-skid surface is embossed on the paper and increases the coefficient of friction by several hundred per cent. It is reported that testing of papers and development of various single and double embossing patterns led the foundation scientists to what is considered the optimum embossed pattern for paper giving the highest amount of surface friction without sacrificing its necessary physical properties. That pattern is a 3/32-inch double-embossed pattern with interlocking square elements. Although originally developed for bags, the new paper was found to be particularly useful in wrapping steel for shipment, the foundation states.

Approve Stock Split

At the annual meeting on April 28 in New York City, stockholders of National Starch Products, Inc., approved a two-for-one stock split and a change in the company's name to National Starch & Chemical Corp. Both actions became effective on May 8. Under the split, the outstanding 981,572 shares, $1 par value, became 1,963,144 shares, 50¢ par value, and authorized shares have been doubled to 4,000,000. Following the meeting, the board of directors declared a regular quarterly dividend of 15¢ payable on May 20 to holders of record May 7. This dividend is equivalent to the 30¢ a share paid in February. Previously, quarterly payments were 25¢ a share.

Forms New Department

Morningstar-Paisley, Inc., New York, N.Y., announces that it has unified the operations of two groups into one department, to be called the Gum and Technical Products Department. According to the company, the new department will coordinate at the product development and application levels all technical activities dealing with gums and other specialties from customer service standpoint. The company also announced that Thomas Morningstar has been named general manager of the department, and Mark Malkovich has been named its sales manager.

names in the news

Judson W. Arnold has been appointed to the newly created post of director of development for Shawinigan Resins Corp., while **D. A. Gendron** has been named general manager of the corporation's Gelvatex Paint Division.

F. B. Patton has been elected senior vice-president for Armour & Co., in which capacity he will assist **Edward Wilson,** executive vice-president, in the administration of Armour's chemical industries divisions.

Ben Chatzinoff, of Consolidated Chemical & Paint Manufacturing Co., has been named president of the New York Paint & Varnish Production Club. **Edward A. Fischer** has been elected vice-president, **John J. Oates,** secretary; and **Raymond L. Whitney,** treasurer.

B. J. Oakes, vice-president of Minnesota Mining & Manufacturing Co., has retired after 31 years of service with the firm.

William O. Blesse has been appointed superintendent of operations at the Chicago phthalic anhydride plant of Witco Chemical Co.

Emerson C. Jones has been named manager of technical service for polyvinyl chloride resins and compounds for the Eleonora Chemical Division of the Pantasote Co.

W. E. Mendham has been promoted from development chemist, Opalon products development group, to chief chemist, plastics development laboratory at Monsanto Canada.

George C. Johnson has been transferred from the Chicago finishes plant of DuPont to the company's South San Francisco finishes plant.

Ernest H. Bluman has been named president of the Harchem Division of Wallace & Tiernan, Inc.

William W. Isbell has been named technical representative in New York for the Chemicals Division of Eastman Chemical Products.

John P. Cheevers has joined the Industrial Chemical Sales Department of Commercial Solvents Corp., as a sales representative.

E. F. Grieb has been appointed manager of American Cyanamid's Fortier plant in New Orleans, La. He succeeds **C. F. Bonnet,** who has been named associate regional director-Europe of Cyanamid International. **T. D. Smith** has been named assistant plant manager and **J. J. Fitzgerald** has been appointed manager of operation of the Fortier plant.

F. L. Scott has been appointed technical manager of the Organic Coatings Division of Metal & Thermit Corp. **R. M. Kary** was named to the research staff at Metal & Thermit.

Robert G. Shaver has been named project leader in the construction chemicals research laboratory of Dewey & Almy Chemical Division of W. R. Grace & Co.

Harold D. Fisher has joined the products control laboratory of the Chemical Division of General Mills, as a chemist.

Allan R. A. Beeber, vice-president of Arkwright Finishing Co., has been named technical representative in the United States for the Winterbottom Industries, Ltd., of Manchester, England.

G. F. Parker, formerly superintendent of development and production of vinyl compounds at Monsanto Canada, has been named technical service manager of the Plastics Department.

Walter Cowan has been appointed head of the Barcwood Division of Barclay Manufacturing Co.

Donald R. Muir, formerly assistant director, has been promoted to director of fiber research at Johnson & Johnson in Montreal.

Leonard E. Canner has been named vice-president of production at Landers Corp.

Portrait Of

Robert T. Schwartz

One of the charter members of the Editorial Advisory Board of ADHESIVES AGE, Robert T. Schwartz is in charge of the Organic Materials Branch of Wright Air Development Center's Materials Laboratory. Since 1939, he has been responsible for the Air Force research and development programs in both plastics and adhesives. He was appointed chief of the Materials Branch in 1954.

Mr. Schwartz received his Bachelor of Science degree in chemical engineering from Washington University. He later obtained a Master of Science degree in Mechanical Engineering from Ohio State University.

For the last 20 years, his work has been largely concerned with the development and application of all types of structural materials required by the fast-changing aircraft industry. Naturally, he has been particularly active in the field of structural plastics and adhesive bonding of metal and plastic structures.

He is personally responsible for a number of significant developments in new techniques for plastic-to-metal bonding. As one of the country's top experts on adhesion, Mr. Schwartz is frequently consulted on improved products and techniques for missile construction and is currently directing a number of important research programs designed to develop adhesives for military applications.

He is a member of the American Chemical Society and the American Society for Testing Materials. Mr. Schwartz is married and has two children.

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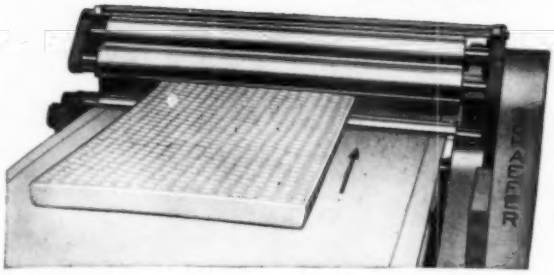

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July 1-19. Chicago International Fair Exposition, Navy Pier, Chicago, Ill.

July 6-10. Gordon Research Conference, Polymers, Colby Junior College, New London, N.H.

Aug. 18-21. 10th TAPPI Testing Conference, Multnomah Hotel, Portland, Ore.

Aug. 29-Sept. 1. National Association of Furniture Manufacturers Supply Equipment and Fabric Fair, Conrad Hilton Hotel, Chicago, Ill.

Aug. 31-Sept. 4. Gordon Research Conference, Chemistry of Adhesion, New Hampton School, New Hampton, N.H.

Sept. 9-11. TAPPI Symposium on the Fundamentals of Fiber Attraction and Bonding, Institute of Paper Chemistry, Appleton, Wisc.

Sept. 10-11. ASME Wood Industries Conference, Multnomah Hotel, Portland, Ore.

Sept. 21-23. TAPPI 14th Plastics-Paper Conference, Edgewater Beach Hotel, Chicago, Ill.

Sept. 21-25. 14th Annual Instrument Automation Conference and Exhibit, International Amphitheater, Chicago, Ill.

Sept. 21-25. 1959 Congress on the International Council for Building Research, Studies and Documentation, Rotterdam, Holland.

Sept. 27-29. National Fibre Can & Tube Assn., Semi-Annual Meeting, The Broadmoor, Colorado Springs, Colo.

Sept. 27-30. American Institute of Chemical Engineers, St. Paul, Minn.

Sept. 28-30. American Oil Chemists' Society, Hotel Statler, Los Angeles, Calif.

Sept. 28-Oct. 2. 14th Annual Hardware Show, New York Coliseum, New York, N.Y.

Oct. 6-8. National Hardwood Lumber Association, Queen Elizabeth Hotel, Montreal, Canada.

Oct. 6-9. 2nd International Symposium on "High Temperature Technology" sponsored by Stanford Research Institute, Asilomar, Calif.

Oct. 7. Society of Plastics Engineers, Cleveland Section, Cleveland, Ohio.

Oct. 11-16. ASTM 3rd Pacific Area National Meeting, Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 13-14. National Technical Conference, Society of Plastics Engineers, Ambassador Hotel, Los Angeles, Calif.

Oct. 18-22. The Electrochemical Society, Inc., Deshler-Hilton Hotel, Columbus, Ohio.

Oct. 19-21. National Paint, Varnish & Lacquer Association, Chalfonte-Haddon Hall, Atlantic City, N.J.

Oct. 19-23. 47th National Safety Congress and Exposition, Conrad Hilton Hotel, Chicago, Ill.

Oct. 20-24. 24th Paint Industries' Show, Convention Hall, Atlantic City, N.J.

Nov. 12-14. National Association of Lumber Manufacturers, Annual Meeting, Washington, D.C.

Nov. 30-Dec. 4. 27th Exposition of Chemical Industries, New York Coliseum, New York, N.Y.

Jan. 12-15, 1960. 16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 26-27, 1960. Society of Vacuum Coaters, Technical Conference, New York, N.Y.

Feb. 2-4, 1960. 15th SPI Reinforced Plastics Division Conference, Society of the Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Plastics-Paper Meeting

The 14th Plastics-Paper Conference of the Technical Association of the Pulp and Paper Industry will take place at the Edgewater Beach Hotel, Chicago, Ill., on September 21 to 23. There will be five technical sessions, the first of which will include the final report and a five-year summary of the work done at the College of Forestry, State University of New York, on the permeability of plastic-treated paper to gases and liquids, known as Tappi Research Project No. 120. Piggyback polymers, nylon extrusion coatings and patent law will also be discussed at this session.

The second session will be a panel discussion on converting and will include remarks on the present and future of waxed papers; saturation papers; asphalt laminated papers; abrasive papers; plastic coated papers; and gummed papers. The third session will feature papers on new coating techniques, quantitative coating control, waste control, statistical control, and a paper on production techniques involved in manufacturing polyethylene coated board. A number of papers are being considered by the committee for presentation at the fourth technical session. The final session will be sponsored by the Plastic Laminates Committee.

Paper Box Committees

Eight standing committees have been announced by the Folding Paper Box Association of America, Chicago, Ill., with committee members to serve until the association's annual meeting in March, 1960. The committees and chairmen are: *Accounting,* Donald Boylan (Ohio Boxboard); *Bakery Package,* S. G. Ellis (Marathon); *Industrial Relations,* Carl Geisler (Marathon); *Public Relations,* Herbert C. Bernard (Shuttleworth Carton); *Retail Box,* Edward M. Deane, Jr. (American Box Board); *Statistics,* Joseph D. Caimi (Associated Folding Box); *Technical and Production,* John Redpath (Chicago Carton); and *Traffic,* Jules W. Deininger (Diamond Gardner).

Transfers Department

Borden Chemical Co., New York, N.Y., has announced that it has transferred its Government Services Department. The department, previously located in New York City, is now at the company's coatings and adhesives manufacturing plant in Middlesex, N.J.

TAPPI Adhesive Group Meets

The Testing of Adhesives Committee of the Technical Association of the Pulp and Paper Industry held a meeting on May 13 at TAPPI headquarters in New York City. Highlight of the one-day session was a paper delivered by Dr. L. Reed Brantley (Lehigh University) on "The Surface Chemistry of Adhesives." The first order of business for the Committee was a discussion on the properties of adhesives which are involved in machining difficulties. The Committee considered methods by which these properties can be measured in a quantative manner. The Committee then took under consideration the publication of "Fundamentals of Tackiness of Liquid Adhesives," by J. J. Bikerman (M.I.T.).

Afterwards, the committee examined various test methods written up by the Gummed Industries Association Technical Session. Under direct examination were glue testing procedures, dextrine testing procedures, and flat paper test procedures regarding curl, to determine if there was anything additional that might be included in them. Concurrent with the test methods examination, the Foil Adhesives Sub-Group examined the progress in testing of foil adhesives.

Members of the Adhesives Testing Committee of the Technical Association of the Pulp and Paper Industry who attended the May 13 meeting. Standing, left to right: Edward Bearman (Morningstar-Paisley); Robert Myers (Dixie Cup); George Schmid (Reigel Paper); Paul J. Shirley, Jr. (Penick & Ford, Ltd.); H. G. Psyras (Union Paste); Robert E. Lafler (U.S. Envelope); and J. P. Carey, Jr. (Dennison Mfg.). Seated, left to right: Dorothy Godshalk (Dixie Cup); William Neuss (Stein, Hall); and Elizabeth Weizenhoffer (Polymer Industries)

Plasticizers For Resins

Union Carbide Chemicals Co., a division of Union Carbide Corp., New York, N.Y., has announced that it is producing two new epoxy-containing plasticizers for vinyl resins. They are being produced in pilot plant quantities, and the company expects both plasticizers to be manufactured on a commercial scale this summer. According to Union Carbide, the new compounds, Flexol plasticizers 107-D and 163-D, function both as plasticizers and as vinyl chloride stabilizers. They are said to be completely compatible with vinyl chloride resins even at concentrations as high as 70 parts of plasticizer per 100 parts of resin.

New Reichhold Plant

Reichhold Chemicals Inc., White Plains, N. Y., has completed the first phase of its $1 million synthetic plant in Houston, Texas. The firm plans to manufacture polyester resins for reinforced plastics and alkyd resins for surface coatings.

Pecora Shows Gains

Pecora, Inc., Philadelphia, Penna. recently conducted a meeting for its salesmen and executives at which the company assessed its efforts during 1958 and evaluated future progress. The company's progress was found satisfactory during the past year and it was forecast that business in 1959 will continue to show gains. In 1958, Pecora experienced substantial gains over a large and diversified product line, which includes tile adhesives, caulking and sealing compounds and related items for industrial consumer markets. A new product which shows increasing sales is Synthacalk, a synthetic rubber caulking compound for curtainwall construction. Two other new products, Tile Stik, a cement type adhesive for thin set applications, and Extruseal, an extruded linear caulking, have also made rapid sales gains. It was predicted that the company's total sales effort, continuing at its present pace, should be up a good 15 per cent for the first half of this year.

Converting Facilities

Cyanamid of Canada, Ltd., plans to convert its plant facilities at St. Jean, Que., to production of formica laminated plastics. The present 17,000 square foot floor space will be increased 50 per cent in order to permit the addition of new machinery needed for formica production. Scheduled for completion in early 1960, the project is expected to cost $1.5 million.

Fluoroelastomer Cement

Connecticut Hard Rubber Co., New Haven, Conn., has developed a new vulcanizing fluoroelastomer cement for Bonding Viton to Viton. The new cement, known as C-328 RTV, is used at ordinary room temperatures and can also be used to bond Viton to metal, the company states. According to reports, C-328 RTV was originally developed to provide a field repair technique for fuel cells made from the presently available Viton fluoroelastomer rubber. Continuing tests have shown that it is versatile enough to be used quite easily as a laboratory or factory technique for bonding cured Viton to itself, to lightly cured Viton, or to metal, the company states. It is claimed that it also can be used to coat fabrics to Viton.

Borden Promotes Two

Borden Chemical Co., New York, N.Y., has announced the appointment of Robert P. Craver as manager of its casein plant, and Robert J. Dunn as manager of its resin and formaldehyde plant. Mr. Craver joined Borden in 1939 as a plant worker and advanced through the years to positions of general foreman, production supervisor, and, in 1955, plant superintendent. Mr. Dunn joined the company in 1950 as an analytical chemist. He was named chief control chemist for the Resins and Chemicals Department in 1953, and became superintendent of the resin and formaldehyde plant in 1956.

Tape Uses Discussed At Packaging Meeting

The role of gummed tapes and automation in the packaging industry was discussed by W. C. Larsen (Minnesota Mining) at the 28th American Management Association National Packaging Conference, held at Palmer House, Chicago, Ill., on April 13 to 15. The conference, held concurrently with the AMA National Packaging Exposition, presented detailed reports on up-to-date techniques and procedures, which were intended to help improve package design and utility as well as manufacturing and handling.

The program consisted of four technical sessions including "Package Design and Package Utility"; "Manufacturing and Handling"; "Persuaders on Parade"; and "Industrial Goods Go to Market." In his paper, "Industrial Tapes Applications," which was presented during the last session, Mr. Larsen stated that pressure sensitive tapes, the most recent development in packaging, offer several advantages. They hold and seal; reinforce and become a structural part of the container; color code; and provide moisture resistance. However, he said, in spite of these advantages, they could not be used to their full advantage if their use could not be geared to modern production methods.

Pressure-Sensitive Tapes

Pressure sensitive tapes, described as being sticky to the touch and requiring no solvents or heat to activate their adhesiveness, have four properties which make them readily adaptable to automatic applications. These were enumerated as: (1) They unwind easily from the roll even though they stick aggressively to other surfaces; (2) They stick at a touch; (3) They stay on and hold; (4) They come off easily and cleanly. Mr. Larsen added that there are at present, about 300 different pressure sensitive tape constructions to choose from. Using slides to illustrate machinery and tape, the speaker then gave brief descriptions of several types of pressure sensitive tapes, suitable applications, application methods, machinery utilized and their advantages.

Mr. Larsen described the Flat Surface Applicator taping head, a simple tape handling device used to apply tape to any reasonably rigid flat surface. It applies premium labels to the tops of coffee cans and squares of tape to sifter type cans such as those used for cleanser. The machine also applies labels for curtain rods, and in two-for-one merchandising, it may be used to apply tape over the juncture of two packages to hold them to a single unit. He also discussed several methods of carton closure and reinforcing. A reinforced pressure sensitive tape, called Filament tape, adheres over the entire area of contact and becomes a structural part of the entire package itself.

Another machine shown had Combination Bundler taping heads incorporated into a two-level conveyor. It applies Filament tape in two directions. The carton, when entering the machine, is taped across the top and bottom and then tumbled 90 degrees. The horizontal taping heads then apply a piece of tape over the heads of the carton. A Box Sealer, he said, is generally used to seal a telescope type carton. By passing the box over the top of the machine, a right angle clip of tape is applied to one side and to the bottom of the box. Box Sealers are so constructed that they can easily be mounted into automatic conveyor systems.

Mr. Larsen also showed two custom built machines. In one of these, paper tubes, containing fine paper, roll down an incline on the machine and a paper cap is automatically put into place on each end. The caps are then taped onto the tubes as the entire assembly is rotated in the machine.

Adhesives in Packaging

W. H. Bromley, director of marketing for the Shawinigan Resins Corp., Springfield, Mass., recently stated that, "The use of synthetic resin adhesives in packaging this year will hit close to 165 million pounds—valued at approximately $40 million." By the end of 1959, Mr. Bromley forecast, the volume of synthetic resin adhesives used for packaging purposes will have grown more than 200 per cent since 1950, when only 53 million pounds were used. Of the 165 million pounds expected to be consumed this year, more than 70 per cent will be based on polyvinyl acetate, he added.

3000 Exhibits at World Trade Fair

Sixty-three nations displayed their principal wares in more than 3000 exhibits at the 1959 U.S. World Trade Fair on May 8-19 at the New York Coliseum. The displays included new products, raw materials, resources, developments and cultural features. New scientific and production advances, new fashions and textiles, new electronic equipment, new precision tools and machinery and new home furnishings were among the 60 major types of products presented in nine over-all classifications.

Twenty-six countries participated with national pavilions which extoled their national attractions. Spain's exhibit encompassed 2300 square feet and contained examples of products such as: leather goods, willow and raffia, floor coverings, ceramic tiles, wood furniture, motorcycles and firearms. Japan, with its pavilion and booths, ran the gamut of arts, sciences and crafts in its varied displays. The Liberian exhibit contained chiefly raw material. Hardwoods in their native state and in finished paneling was shown. Rubber latex, gold, iron ores, coffee beans and bauxite were exhibited.

One entire floor at the Coliseum was transferred into a huge international bazaar and food festival where visitors were able to sample beverages and delicacies of other lands.

Hooker Research Center

Hooker Chemical Corp., Niagara Falls, N. Y., has dedicated its new $3,800,000 Research Center at Grand Island, near Niagara Falls. Incorporating the latest features of laboratory design, construction of the building was begun in October, 1957, and the facility was virtually completed last January. It is now occupied by nearly 300 people. Hooker's corporate research and product development of chemicals and plastics is largely centralized at that location.

Completes Dry Glue Unit

Chemical Process Co., Redwood City, Calif., has completed a 9,600 square foot modern dry glue blending plant and warehouse at Redwood City. Having a 5 million pound annual capacity, the plant will handle the company's line of soya-blood adhesives, which are used in plywood plants in Northern California and the Pacific Northwest.

REPORTS *on concrete bonding with* THIOKOL *LP/Epoxy compounds*

TEST OF STRENGTH. Concrete beam broken in flexure was then cemented together with a Thiokol LP/epoxy adhesive. Broken a second time, beam failed at point other than the adhesive line. Adhesive stands up though concrete gives way.

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ASA Accepts Sealant

The American Standards Association accepted a specification for polysulfide-base sealing compounds for the building trade as an American Standard at its general conference on April 9, at the Penn-Sheraton Hotel, Pittsburgh, Penna. A specification for polysulfide-base sealing compounds had been developed by a technical committee and was presented to the conference. However, members of the Adhesives Council presented an improved specification which proved satisfactory to all concerned. The conference then accepted the specification, subject to general acceptance after a mail vote by all concerned. The specification was then assigned to the American Society for Testing Materials under the proprietary method. Under this method, ASTM will handle all future revisions of the specification.

According to the technical committee, the specification is important as an American Standard to the construction industry because it implies a definite level of performance for elastomeric polysulfide sealants to be used in present curtain wall components as well as in other rigorous environments; it greatly simplifies the problem of specifying materials to be used in these environments; and it will protect the architect, engineer, and specifier by designating a definite quality of material.

DuPont Adhesive Yarn

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has developed a new adhesive-finished, high-tenacity rayon yarn for use as reinforcement for mechanical rubber goods. The new yarn is said to have 40 per cent greater retention of adhesion when wet than conventional RFL-dipped rayon and also has higher yarn friction. Fabric dipping is not necesary to impart an adhesive quality. Super Cordura Type 272-F can be processed on conventional industrial weaving equipment, DuPont states.

Wisconsin Names Agents

Wisconsin Protective Coating Co., Green Bay, Wisc., has appointed sales representatives in various areas of the country. F. W. Wolchek, Kenmore, N. Y., will cover western New York State; J. P. Fuller, Inc., Elizabethton, Tenn., will cover eastern Tennessee, western Virginia and northern Alabama; Industra Co., Minneapolis, Minn., will cover Minnesota and northern Iowa.

Bonds Vinyl to Fabric

A British Patent, No. 809,290, is said to eliminate the difficulty of getting a good bond between polyvinyl chloride and almost any textile-fiber surface by treating the cloth with an epoxy resin. A suitable resin can be made by condensing resorcinol with epichlorhydrin to yield a polymerized glyceryl polyether. Diethylene triamine is added to the solution to accelerate hardening.

The material is impregnated in a dispersion of epoxy resins, the hardener and some polyvinyl chloride in a mixture of acetone and methylcyclohexanone. Then it is dried to drive off the solvents, heated to 80 to 100°C., and cured for 3 to 5 minutes at 180 to 200°C. When the polyvinyl chloride is applied to materials that have been pre-treated in this way, a strong bond is obtained.

Coates Plans Expansion

Coates Board & Carton Co., Inc., Garfield, N. J., has launched a major expansion and improvement program at a cost of more than $1 million. According to C. I. Wilson, president of the company, the current program is being carried out to materially increase plant capacity and production efficiencies and to improve quality and service to its customers. In excess of 100,000 square feet of additional floor space is provided at the Garfield plant with the recent acquisition of a building adjacent to the present facility. This new building will give Coates about a 60 per cent increase in working area. In addition to the expansion of facilities in Garfield, the company's mill at Stroudsburg, Penna., will also acquire added equipment and facilities to assure an adequate supply of high grade folding boxboard. Present plans call for the project to be completed by the end of 1959.

Rome Plans Expansion

Rome Kraft Co., Rome, Ga., has announced that it has awarded Rust Engineering Co. a $28 million contract to expand its operation at Rome, Ga. According to the company, estimated capacity will be 500 tons per day for container board, corrugated boxes, corrugated medium and liner board.

Hooker Appoints Three

Hooker Chemical Corp., Niagara Falls, N.Y., has appointed William J. Parmley as works manager of its Durez Plastics Division plant in Kenton, Ohio. The company also announced that Henry P. Puff has been promoted to assistant product manager for the Durez Plastics Division in North Tonawanda, N.Y., and Edwin E. Woodman was named as district sales manager for the division's Chicago office, succeeding Mr. Puff.

Mr. Parmley graduated from the New York State College of Forestry with a B.S. degree in 1943, and joined Hooker the same year. In 1956, he was supervisor of laboratory production and process development at the North Tonawanda plant, and in 1958, he became plant superintendent at Kenton. Mr. Puff joined the Durez Division as a chemist in 1946 after graduating from Bucknell University with a B.S. degree. He transferred to the Chicago office in 1947, and has been district sales manager there since 1956.

Mr. Woodman studied engineering at Kansas State Teachers College, and joined the Durez Sales Department in 1931. He has been a sales representative in the Chicago district for more than 20 years.

NAFM European Tour

The National Association of Furniture Manufacturers, Chicago, Ill., has announced that 30 of its members will be embarking on a three week European trip on September 7, to survey the European scene of furniture design, production methods and new machinery being utilized. The group will cover six countries, England, Netherlands, France, Germany, Sweden and Denmark, and will be looking for elements that could inject big improvements in their own operations and finished products. Time will also be given to observing furniture retailing methods in a few major cities of the European countries on the itinerary.

Ciba Moves Offices

Ciba Co., Inc., has announced that it will move its headquarters from New York City to a recently completed building in Fair Lawn, N.J. Participating in the move will be the company's central staff, customer service laboratories, central warehouse facilities, metropolitan district sales offices, and laboratories.

NAFM Fair Exhibits New Adhesive Products

The important part played by adhesives in the manufacture of furniture will be demonstrated at the 1959 NAFM Supply, Equipment and Fabric Fair, when suppliers to the furniture industry exhibit latest materials and developments in the field. The Fair will be held by the National Association of Furniture Manufacturers at the Conrad Hilton Hotel in Chicago, Ill., from August 29 to September 1.

One of the exhibitors, Franklin Glue Co., Columbus, Ohio, will show a new production material which is claimed to have unique properties, great versatility and broad applications. Offered for a variety of uses, Franklin's Multibond Adhesive is permanently pressure sensitive, adheres to a wide variety of materials, can be applied as 50 per cent solid from water emulsions that are non-flammable, and has non-toxic vapors. The material is available in different grades and variants to meet the specific needs of the user and can be stripped clean of most adhered objects. The newest applications of a fast drying, cold, ready-to-use glue called Multibond 370 will be shown along with a demonstration of Titebond in large scale edge-gluing operations.

A line of wood treatments for stabilizing and preserving woods will be shown by National Casein Co., Chicago, Ill.. In addition to the Woodtrol line, the firm will show its urea resin glues, casein glues, polyvinyl glues, resorcinol glues, contactbond, etc. Examples of glued articles will be exhibited.

Decorative Laminates

New patterns in Farlite High Pressure decorative laminates will be introduced by the Plastics Division of Farley & Loetscher Manufacturing Co., Dubuque, Iowa, Other items on display will include 1/16 inch samples of Farlite high pressure laminated plastics, 5/32 inch thick samples of Farlite and 13/16 inch and 1¼ inch double veneered Farlite panels. In all, about 100 samples of Farlite high pressure laminates will be shown along with samples of cork construction and other details of manufacture in fabricating the Farlite plastics.

Fiberesin Plastics Co., Oconomowoc, Wisc., will show its latest achievements in developing unusual designs and textures in solid plastic panels. Innovations in custom patterns and some textured matte surfaces will be highlighted. Furniture from newest collections of leading manufacturers using Fiberesin will be displayed to illustrate the design and textural possibilities of this plastic panel. Also important will be the display of Fiberesin woodgrain plastic panels including maple, walnut, teak, oak, mahogany and others. According to the company, advantages of Fiberesin are that it is practically indestructible, cannot warp, split, or be harmed by food, alcohol or burning cigarettes.

Staley researchers, John V. Tuschoff (left) and Clifford E. Smith, co-developers of the new acetylation process for non-congealing starch products, check test specimen on a viscometer.

Staley Introduces New Process

Staley Manufacturing Co., Decatur, Ill., has filed a patent application on a new process developed by company researchers, John V. Tuschoff and Clifford E. Smith, which is based on an entirely new starch reaction. The process, which has been used in the development of a new series of non-congealing starch products, is said to be unusual in its simplicity and ease of control and to make possible exceptional uniformity in its products. According to the company, Mira-Film, the first perfected product in the new Staley series of starch-derived acetate gums, shows distinct advantages in a wide range of surface sizing and coating applications.

Mira-Film acetate gums are made by the acetylation of corn starches. Although the degree of acetylation of each product is not great, properties of the resulting products are said to differ greatly from the original starches. Mira-Film acetate gums range from high to very low viscosity. Staley states that these gums have outstanding paste and film-forming properties and make pastes of excellent flow with minimum penetration into body stock. They have good waterholding characteristics and produce films of unusual flexibility.

To Expand Division

General Tire & Rubber Co., Akron, Ohio, has announced plans for a $1 million expansion of its Textileather Division. Included in the expansion plans is a new building and a high speed calender to produce unsupported vinyl sheetings, laminated vinyl materials, and semi-rigid plastics, the company states.

Joins National Starch

National Starch and Chemical Co. (Canada) Ltd. has announced that Walter T. Parry has joined the company as a technical sales representative handling the promotion of specialty starches and resins to the paper industry. Mr. Parry, who was previously associated with the paper division of a leading Canadian chemical company, received an Honors B.A. degree in chemistry from Queens University in 1954.

Pecora Plans New Unit

Pecora, Inc., Philadelphia, Penna., plans to build a new plant in Garland, Texas, to meet increasing demand for the company's products in the southwestern sales area. The firm manufactures caulking compounds, tile adhesives and other products for industry. The brick and curtain wall structure will be built on a two acre site and will permit plant expansion of 250 per cent of the initial area.

By MELVIN NORD

Starch Pasting System

U. S. Patent 2,871,146, issued January 27, 1959 to Oliver R. Etheridge, assigned to A. E. Staley Mfg. Co., describes an apparatus for preparing starch slurries and continuously pasting or cooking them.

As shown in the schematic below, dry starch is introduced (for example, by emptying 100 or 150 pound sacks) into a tank (5) and mixed with water which is introduced through a trip-type water meter-valve (8). From time to time, proportionate charges of dry starch and water are added to the tank, to keep the amount and concentration of dispersion substantially constant.

The starch slurry is withdrawn through a strainer (13) into a slurry pump (17), and is pumped to a control panel (30), the excess being bypassed from a pressure-relief valve (33) to the tank (5).

The control panel unit (30) receives the concentrated starch, water, and steam, and operates automatically to combine and process these materials so as to produce a constant predetermined volume of uniformly pasted or cooked dilute starch solution which is discharged through a line (40). The patent describes the operation of the control unit (30) in detail.

Gap-filling Adhesive

U. S. Patent 2,873,260, issued February 10, 1959 to John F. Corwin, assigned to Koppers Co., Inc., describes the production of improved cold-setting gap-filling urea-formaldehyde adhesives having plasticizing amounts of dimethyl formamide sufficient to afford improved properties to glue lines, particularly that of craze resistance.

It appears that dimethyl formamide functions as a solvent-plasticizer which is strongly retained by urea-formaldehyde condensates to afford improved gap-filling adhesives.

Lacquers on Polyethylene

U. S. Patent 2,873,241, issued February 10, 1959 to Anton Strzysewski and Willi Geilenkirchen, describes a process for improving the adhesiveness of lacquers and printing colors on polyethylene products.

The process consists of contacting the surface of the polyethylene product at 0 to 75°C. with a chlorinated hydrocarbon (such as perchloroethylene), while simultaneously irradiating the surface with ultraviolet light. The treatment does not involve any visible or otherwise detrimental change of the polyethylene surfaces.

Rubber-to-Fabric Bonding

U. S. Patent 2,835,624, issued May 20, 1958, to Edward Cousins and assigned to Goodyear Tire & Rubber Co., relates to a method of effecting a bond between butyl rubber and materials such as regenerated cellulose, nylon, cotton and other fibers, for use in tires.

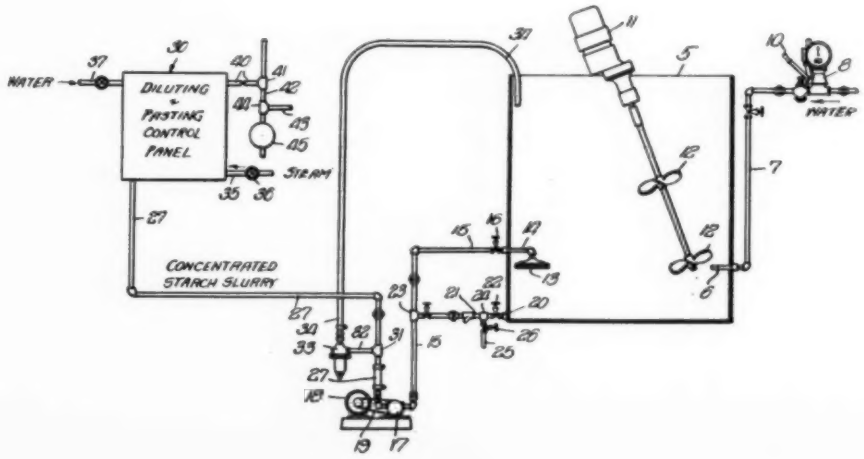
The objects of this invention are accomplished by applying to yarns, filaments, cords, fabrics or the like a butyl rubber containing an organic isocyanate and an aromatic dinitroso compound or an aromatic dioxime, and bonding the resulting composite structure to butyl rubber by associating the composite structure with unvulcanized butyl rubber, and vulcanizing the same.

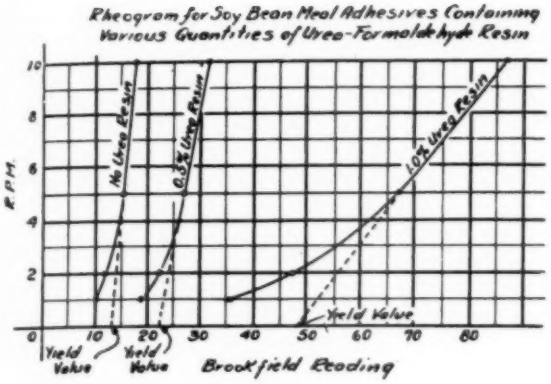
Thus, butyl rubber is mixed with an organic isocyanate and an aromatic dinitroso compound or an aromatic dioxime to modify its properties and to improve its adhesiveness to filaments, fibers, cords, fabrics, and the like. The exact nature of the reactions occurring is not known, but an improvement in adhesiveness is obtained and a decrease in the plastic flow of the rubber results.

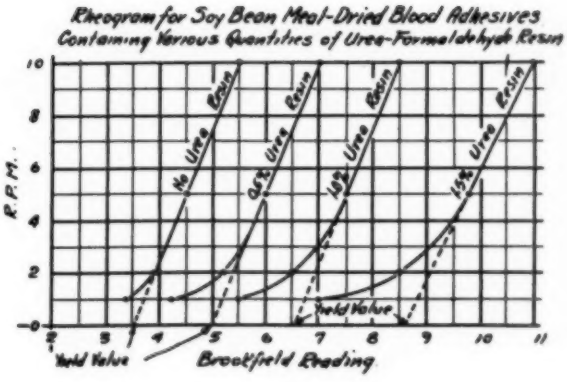
Gelatin Adhesive Layers

U.S. Patent 2,867,542, issued January 6, 1959 to Lodewijk F. De Keyser and Lodewijk A. Van Dessel, assigned to Gevaert Photo-Producten N. V., relates to the use of alginyl nitrate in gelatin-containing adhesive layers, in order to make them more adherent to hydrophobic layers such as cellulose ester films.

The alginyl nitrate is produced by causing fuming nitric acid to react with alginic acid or sodium alginate.







Plywood Adhesive

U. S. Patent 2,872,421, issued February 3, 1959 to Frederic J. Shelton and Charles H. Chervenka, describes an improved wet mixed plywood adhesive and a fast cold pressing plywood gluing process.

A combination of an alkaline proteinaceous adhesive such as soybean meal, dried blood adhesive, and urea-formaldehyde resin is used, which possesses a greater tackiness than any straight proteinaceous adhesive. This property enables the gluing of plywood at extremely short cold pressing times compared to conventional plywood gluing processes.

The adhesive produced is a colloidal dispersion having the non-Newtonian flow characteristics indicated in the graphs above. It has higher yield values than adhesives not containing the resin and does not flow as much. The yield value is also identifiable with the dry bond strength of the glue.

Glue from Soluble Blood

U. S. Patent 2,874,134, issued February 17, 1959 to John M. Gossett, Max H. Estep, Jr., and Mahlon J. Perrine, assigned to American-Marietta Co., describes a process for the production of glue from soluble blood. The glue produced is particularly useful in the manufacture of plywood, as it minimizes staining of a light-colored thin veneer.

An aqueous solution of soluble dried blood is coagulated by heating to above 120°F. by the addition of boiling water with agitation. The resulting aqueous dispersion of coagulated blood is cooled below 120°F., and sodium silicate is introduced with agitation into it to raise the pH to 9 to 9.7. This also swells the blood particles and increases the adhesive properties of the blood dispersion and its viscosity. The penetration properties of the resulting glue are then reduced by reducing the pH below 9.

Self-Sustaining Sheet

U. S. Patent 2,872,365, issued February 3, 1959 to Norman A. de Bruyne, George S. Newell, and Keith R. C. Perry, assigned to Ciba Ltd., describes a process for making a self-sustaining adhesive sheet.

The sheet consists of a strippable support sheet carrying on it, in order: (a) a layer of heat-hardenable resin composition, (b) a layer of particulate polyvinyl acetate, and (c) a layer of heat-hardenable resin composition, these layers being at least partially merged with each other.

Other Patents of Interest

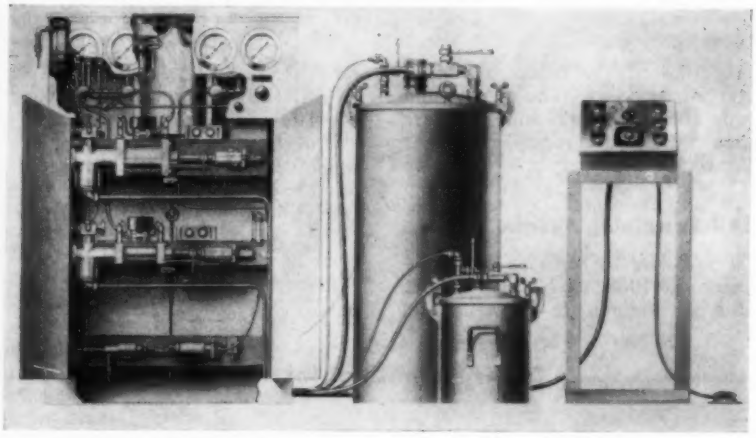
Subject	Inventor or Assignee	Patent No.	Date
Adhesive applying machine	Compo Shoe Machinery Corp.	2,867,189	1/6/59
Apparatus for preventing slippage of tape rolls	Clarence W. Vogt	2,867,317	1/6/59
Combined housing and tape retaining means for tape holding reels	Thomas S. Kulka	2,867,318	1/6/59
Paper-gumming machines	Societe Anonyme dite: "La Charfa"	2,868,157	1/13/59
Machines for applying heated thermoplastic adhesives	United Shoe Machinery Corp.	2,868,160	1/13/59
Apparatus for applying stripes of thermoplastic cements to flat blanks	United Shoe Machinery Corp.	2,868,161	1/13/59
Tape dispenser	J. H. Perry	2,868,402	1/13/59
Hydraulic cement compositions	American Cyanamid Co.	2,868,753	1/13/59
Paperboard container having a release coating, for use with tacky products	Fibreboard Paper Products Corp.	2,869,722	1/20/59

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D. C., for 25 cents each. Do not send stamps.

new equipment

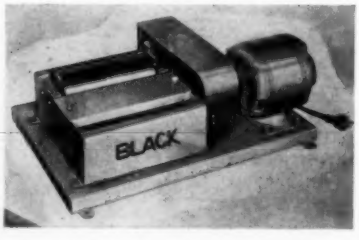
Resin Processing System

Lowered production costs and improved product quality are two advantages said to be provided by automatic equipment for proportional metering, mixing and metered dispensing of multi-component reactive liquid resins. The NoVo metering and mixing equipment, as it is called, is recommended for adhesives, sealers and similar products. The equipment is claimed to cut production costs substantially by maintaining uniform high quality of product and to increase speed of processing, application and curing. The systems are supplied as completely integrated units mounted on a metal frame and enclosed in a sheet metal housing. They average 120 dispensings per minute, or produce a continuous bead of the mix. The unit can be used continuously or intermittently for production, pilot or laboratory operation. It is adjustable for a wide range of ratios, and handles ultra high viscosities at room temperature. *Mitchell Specialty Division, Industrial Enterprises, Inc.* E-90



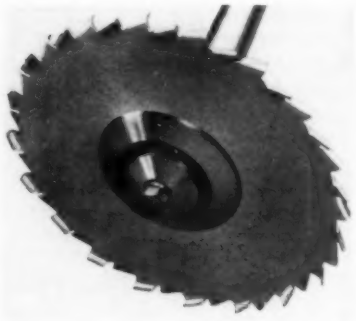
Bench Glue Spreader

A bench glue spreader intended for light edge gluing and similar operations comes with a 4-inch diameter and 8-inch length roll. The unit can be supplied either as a hand turned machine for cold glues only or with a motor drive. The hand turned bench spreader includes a corrosion resistant glue tank fitted with bearings for the shafts. The roll is accurately balanced, helically corrugated and is turned by the pressure on the stock passed over it. An adjustable scraper controls the depth of the glue film, and the roll may be lifted out for easy cleaning. Optional equipment, in addition to the motor drive which is recommended for all types of glues, include an electric heating element, a resilient roll instead of the metal one, a water jacketed glue tank, an upper friction feed roll, a power driven upper feed roll and a floor stand. *Black Brothers Co., Inc.* E-91



Improved Impeller

Development of an improved impeller design for use on various models of the Cowles dissolver is said to enable faster production of most types of structural adhesives, glues and related materials in minimum and maximum batches according to the needs of the processor. Powered by motors ranging in size from 1 through 50 hp, the narrow impeller vanes travel at speeds of up to 6000 feet per minute. At high velocity the material impinges on surrounding slower moving portions, hydraulic attrition takes place, so that most of the actual work of dispersion is accomplished by the action of the suspension on itself. Viscosities even in excess of 50,000 centipoises are claimed to be easily handled by the machines. The impellers are available in diameters of from 3 through 24 inches. *Morehouse-Cowles, Inc.* E-92



Specific Gravity Indicators

Instruments for the continuous measurement of liquid specific gravity in processing systems eliminate manual sampling with its uncertainties about proper technique and time-delay in obtaining the required information. Also the hazards from sampling and transporting hot or corrosive liquids are removed. Within the pressure rating of the instruments specific gravities of the liquids in systems at temperatures above their atmospheric boiling points can be measured. The liquid flows through the indicator in a continuous stream, contacting a float-type hydrometer and thermometer. The specific gravity and temperature can be read at a glance. Normally all liquid-contacting parts are steel construction, though a range of corrosion-resistant materials is available as service conditions dictate. *Schutte and Koerting Co.* E-93

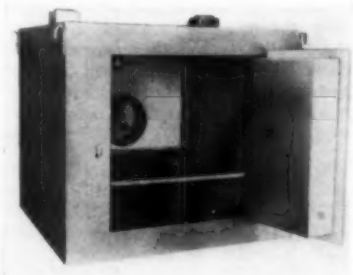
Precision Spray Gun

A small precision spray gun, called type P-EGA, is said to feature extreme accuracy, delicate control and ease of handling. The gun is designed to spray all common materials. A ball

and cone principle of alignment of nozzle parts assures perfect metal to metal seal and perfect centering. Spray patterns are symmetrical and material coverage is uniform. Knurled adjustments at the rear of the gun provide precise adjustment of fluid flow and spray pattern size. The gun is built of corrosion-resistant materials and is heavily plated for easy cleaning and long service. *DeVilbiss Co.* E-94

Basic Oven

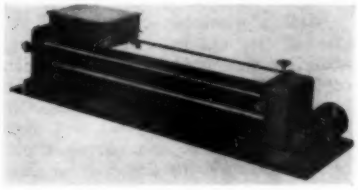
A new basic oven for controlled heating processes up to 650° F.



comes with all extras optional. The oven is designed to meet the demand for custom-made heating without the expense of extra equipment which may be unproductive for the small shop. Designated COF, the oven has the manufacturer's Folded-and-Formed heating elements, 3-inch glass wool insulation, steel casings, direct drive fan, a single-hinged door with explosion release latch, and one shelf. It is available in four sizes and three voltages, with or without forced air circulation. Optional equipment includes legs, double doors, additional shelves, door switch, adjustable blast gates and three separate types of control. *Trent, Inc.* E-95

Bench-Type Coater

The Walco coater, a new bench-type unit, is recommended for pilot plant and laboratory use when the application of coatings, including adhesives, to flat surfaces is part of



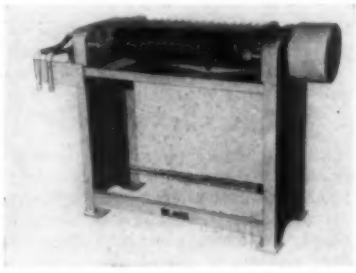
the processing operation. The machine is powered by a ¼-h.p. motor with gear reducer. The unit features precision ground steel rolls, the doctor being 2⅛ inches and the applicator 4 inches. The rolls are also available in butadiene-acrylonitirle, neoprene, polysulfide and other rubbers in lengths from 8 to 52 inches. Feeder and take-off conveyors with dryers are also available. *L. R. Wallace & Co.* E-96

Polyethylene Syringes

Helix syringes are designed to apply adhesives, bonding agents and potting compounds in precise amounts without dripping, flooding or starving. The syringes are made of unbreakable, precision-molded polyethylene with no rubber gaskets. Blunt-end, 1½-inch steel hypodermic-type needles are available for use with the syringes. The instruments may be cleaned by soaking them in Helix Solvent 101, a product which softens and dissolves epoxy compounds. The syringes are available in ⅛ and ⅔-ounce sizes. *Carl H. Biggs Co.* E-97

Roll Glue Spreaders

A line of roll glue spreaders, designated Series 567, is recommended for edge gluing and similar operations. The machines are available in 12, 18 and 24-inch roll widths, with 8½-inch diameter rolls. They are



used with any kind of glue in common use except synthetic resin. The spreaders are available with metal rolls, brush rolls, synthetic rubber covered rolls and combination brush-and-metal rolls. The metal rolls are usually used with hot glues and casein; the synthetic rubber rolls with all glues. The units come with a water jacket around the glue tank which may be used to provide steam, electric or gas heat for hot glues, or to circulate cold water to reduce the temperature of cold glues. Standard equipment includes jacketed tank with legs, metal gluing roll, power-driven doctor roll and built-in motor drive. *Black Brothers Co., Inc.* E-98

Industrial Liquid Strainers

Econex single-basket strainers are designed for medium and fine straining of industrial liquids at pressures up to 125 psig (cold). The strainers are available in sizes from 2 to 6-inches, inclusive. Cast iron construction is used for bodies and covers. Ductile iron serves in the quick-opening cover clamp. Stainless steel cylindrical baskets with ⅛-inch perforations are standard. Baskets are also made with fine mesh stainless steel screen liners for fine straining. *Schutte and Koerting Co.* E-99

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

book reviews

Silicones. ***By Robert N. Meals and Frederick M. Lewis. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. 5 x 7½ in. 268 pp. $5.95.***

Silicones find application in so many products that they may truly be said to be of universal interest. The adhesives manufacturer, needless to say, is among those most concerned about new developments in the silicones field. He will find much of interest by a perusal of this volume, which has been authored by two members of the Silicone Products Department of General Electric Co.

The purpose of the book is to present a readable semi-technical account of the applications of silicones, and only enough scientific background has been included to make the book reasonably self-contained. It is not an exhaustive reference work. A listing of the chapter titles, however, will give an idea of the excellent general survey which the authors have made.

(1) Introduction (which presents information on the kinds of silicones, outstanding characteristics, competitive position, chemical development and related subjects); (2) General Properties; (3) Basic Chemistry; (4) Manufacture and Fabrication; (5) Applications of Silicones; (6) Future Prospects of Silicones.

Closing the book are a ten-page appendix on organosilicon compounds, a short bibliography intended to guide the reader toward the thousands of publications and patents dealing with silicones, and a subject index.

Because of the great number and variety of applications for silicones, many had to be omitted from this small volume, and others were treated very briefly. Even though there is a good deal of overlap with rubbers and resins, which are given extensive presentation, adhesives are sufficiently important to rate a two-page discussion by themselves. Information is given on silicone pressure-sensitive adhesives, particularly in reference to tapes; use of silicone resins, cured to hard films, as bonding materials; and silicone rubber compounds used for adhesive purposes.

This book is eleventh in a series started by the publisher in 1957 on plastics applications. It is a worthy addition to the series, and contains much valuable information presented in a highly readable and concise way. Design engineers, formulators and manufacturers will find it well worth the shelf-space it occupies.

Developing Executive Skills. ***Edited by Harwood F. Merrill and Elizabeth Marting. Published by American Management Association, 1515 Broadway, New York 36, N. Y. 6¼ x 9½ in. 432 pp. $9.00 (non-members); $6.00 (members).***

The shortage of executive manpower is one of management's most serious problems. So much so that it is common business practice today, especially in the larger companies, to have an organized program for the proper selection of personnel, and to provide junior members of the company with the necessary stimulus, training and chance of promotion which insures the gradual development of the capable, well-rounded executive.

After a wholesale adoption of the idea of management development, a shift in emphasis has of late been perceptible. In many instances those responible for the plans have been dissatisfied with the results. Still convinced of the basic needs involved and of the benefits to be drawn from management development, they are asking themselves just why efforts many times seem to fall short of the mark.

This book, designed to replace AMA's "Development of Executive Talent," published in 1952, offers a comprehensive presentation of this vital subject. The latest information on management development—its background, requirements, and specific tools and techniques—is included. Selected material from the original volume has been thoroughly revised and brought up to date. Many completely new company case studies in executive development are included.

The book is divided into two parts. The first, "Essentials of Management," opens with an introductory paper on "Does Management Development Develop Managers?" This is followed by two sub-divisions, each containing a number of papers, on "The Program and Its Setting" and "Tools and Techniques."

The second part, titled "A Look at Company Experience," contains case history material on some of America's largest companies. In addition there are sub-divisions on "Progress in Production Management," and "A Word by Small Business." The concluding paper is on "Developing Tomorrow's Leaders." The papers in both sections were authored by leaders from industry or prominent universities. A bibliography of supplementary reading and a subject index close the volume.

This book is a timely and valuable publication. The great wealth of information it contains happily emphasizes the specific details of how the various organizations operate and what they do in particular situations or to achieve certain goals. It is recommended reading.

Trade Literature

Diluent for Epoxy Resins. A 4-page technical data bulletin presents data on limonene dioxide, a colorless liquid combining the reactivities of an internal and an external epoxy group in the same molecule. Typical properties are listed, and information given on hazards, availability and reactions and applications. Limonene dioxide can be used not only as a modifier of conventional epoxy resins but also as a primary building block for an epoxy resin system. Its use in epoxy resin systems for such applications as adhesives, castings and coatings is visualized. *Chemicals & Plastics Division of Food, Machinery and Chemical Corp.* L-98

Bonding Scrap Foam. A 4-page brochure gives information on the technique of bonding polyurethane and foam rubber scrap into new sheets or molded foam products with a self-curing liquid rubber polymer which vulcanizes as it dries. Details are given on drying procedures and methods for controlling both the texture and density of the finished product. Suggested possible uses are in the manufacture of toys, shoes, displays, upholstery, mattresses, pillows and rug underlays. The same techniques can be used for making flexible cork sheets from cork granules. *Rubba, Inc.* L-99

Coating Operation. A coating operation and the materials and techniques associated with it are described in an 18-page bulletin. The vacuum metallizing operation is a process whereby a reflective mirrorlike surface is applied to items made of almost any non-porous material. Coatings applied before and after the metallizing operation govern the results as to both appearance and durability. Complete technical information on the process and its advantages is supplied in the booklet. *Logo Division, Bee Chemical Co.* L-100

FOR MORE INFORMATION on the trade literature reviewed here, use the Reader's Service Card elsewhere in this issue.

Trade Literature (Cont'd.)

Labels. A handsome 48-page book shows hundreds of labels, seals and tags, reproduced in full color. Design of the labels and the jobs they are intended to do are discussed. Many ideas for using labels and tags to facilitate product handling, office systems, shipping procedures and related operations are included. A brief description of the necessity for the proper selection of adhesive and paper is a part of the presentation. In relation to adhesives the labels discussed include water gummed, pressure-sensitive, heat seal, strip cohesive and ungummed. *Allen Hollander Co., Inc.* **L-101**

Structural Sealing. Structural sealing with elastomeric type sealants based on liquid polymers is the subject of a 12-page bulletin. Data on where use of these sealants is applicable on structures are provided. How to prepare the surface is described, as is the proper method of mixing the room-temperature curing polymer with the curing agent. Extensive information on testing for adhesion and stress, sag, low temperature, resistance to weather and peel strength is also given. *Thiokol Chemical Corp.* **L-102**

Liquid Level and Flow Control. Information on how to provide operating and safety controls for a wide variety of jobs involving liquid level and liquid flow is presented in a 24-page bulletin. How float-operated valves and switches and flow switches provide solutions for many other frequently encountered control problems is also shown. Full engineering information and 21 case studies are included. *McDonnell & Miller, Inc.* **L-103**

Packaging Guide. Helpful information on selection of the proper corrugated packaging for a new or existing product is given in a 32-page fully illustrated book. The opening section is on basic design of corrugated boxes. The second, on special corrugated box designs, illustrates and details 56 box designs developed in response to specialized product and marketing requirements. *Hinde & Dauch Division, West Virginia Pulp and Paper Co.* **L-104**

Loading Assemblies. A new 2-page bulletin describes how to select loading assemblies. These are widely used in industry wherever large quantities of fluid are loaded or unloaded. The bulletin shows how to determine size, range type (scissor arm or slide sleeve), materials required and balance type (spring or counter balanced). Two loading assemblies are illustrated. The bulletin also features a full description, illustrations and a cutaway photo of shockless, adjustable loading valves. *OPW-Jordan.* **L-105**

Industrial Sterilization. A 12-page booklet has been prepared for the increasingly large number of industrial firms that include sterilization as an integral part of product processing.. The sterilization-engineering service offered by the publisher is described, and information given to assist manufacturers and laboratories in choosing the best sterilizing medium for their products. The virtues and limitations of steam and dry heat methods are discussed, and a special section is devoted to the newly developed gas sterilization. A final section describes facilities and services available to customers. *Wilmot Castle Co.* **L-106**

Silica Gel. A 4-page brochure reprints a technical article which describes the mass production of silica gel by a new continuous process. The process is described in detail and a schematic flow sheet showing the step-by-step procedure is included. In addition to the systems story, specific detailed information on the materials handling problem is included. *Sprout, Waldron & Co., Inc.* **L-107**

CLASSIFIED ADVERTISING

Rates: All Classifications except Positions Wanted:

Undisplayed, per inch or fraction..$20.00

Boxed, per inch or fraction.....$25.00

(Approximately 60 words per inch unboxed; 50 boxed. Count 5 words for box number address.)

Positions Wanted:

Set solid, no separate headings or boxes ..... $2.50 for 25 words or less; extra words, 10¢ each. Count 5 words for box number address.

Replies will be forwarded via ordinary mail without charge.

Note: Cash must accompany order.

POSITIONS WANTED

POLYMER CHEMIST—B.S. Age 36. Experienced in research, development and technical service. Varied polymer background includes epoxies and polyesters. Interested in position in or out of laboratory. Limited travel. Address Box A-116-P, ADHESIVES AGE.

HELP WANTED

ADHESIVE CHEMIST—Capable of formulating pressure-sensitive adhesives for tapes and liner-back products. Plant located near Chicago. Company interested in expanding present line. Has been in business 12 years and sales are increasing every year. Send resumé of experience, age, education and firms associated with. All replies confidential. Address Box A-117-W, ADHESIVES AGE.

BUSINESS OPPORTUNITIES

CUSTOM MILLING AND SOLVENT DISSOLVING to your specifications. Latest heavy duty equipment and careful laboratory control. Please write POLYTEX ADHESIVES CORPORATION, 41 Midland Ave., Wallington, New Jersey.

EQUIPMENT FOR SALE

FOR SALE—World's largest stock of Baker-Perkins sigma blade, jacketed mixers: (43) 200 gal., (4) 100 gal., (5) 50 gal., (2) 35 gal. Prices are lower than ever before! Phone or write for details. PERRY EQUIPMENT CORP., 1414 N. 6th St., Philadelphia 22, Pa.

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in passing

The More the Merrier

Almost every month one or more of the mass consumer magazines contain references to adhesives. Three such references appeared in recent weeks. The March 23rd issue of *Life* carried a two-page story on epoxies, the March issue of *Popular Science* had a four-page article on contact cements, and the April issue of *Mechanix Illustrated* had an article on glues and gluing.

The contact cement article outlined three separate ways in which these stick-to-itself adhesives can be applied and offered five specific tips on using them. The glue feature covered specific brands and included a table showing preparation, application, temperature requirements, setting time and characteristics. Glues mentioned included liquid animal and fish, powdered casein, resorcinol, liquid resin, powdered resin and flake animal.

The treatment given to the epoxies in *Life* was a little more dramatic. For example, the first page showed a football player dangling from the crossbar of goal posts, with his helmet cemented to the bar. Dramatic—but effective. Of special interest to us was one of the other illustrations, showing the application of Teflon to propeller blades. The reason? The application is one carried out by Hamilton Standard at its Windsor Locks, Conn., plant, and we expect to publish a feature article on it in can be applied and offered five specific tips on an early issue.

And at Geneva

A comment upon the present world situation is making the rounds at Geneva, site of the foreign ministers' conference. The story goes like this: In the United States, everything is permitted which is regarded as correct by women's clubs . . . In Great Britain, everything is permitted which is not prohibited by law . . . In Germany, everything is prohibited except that which is permitted by law . . . In France, everything is permitted including the prohibited things . . . In Russia, everything is prohibited including the permitted things.

Other Side of the Coin

The age of "hurry up" does have side effects. "We've waited 25 years to make this trip, and we're certainly not interested in getting there in any six and a half hours," is a viewpoint firmly expressed by a vacation-bound lady in a recent *New Yorker* cartoon. Makes you think.

18 Pounds per Car

It is conservatively estimated that approximately 18 pounds of plastics materials were used in the average car produced in the United States in 1958. This compares with 11 pounds used in 1954 and 15¼ pounds used in 1956. In total, the automobile industry used almost 100 million pounds of plastics in 1958. It has been predicted that by 1963 the automobile industry will reach a per-car usage of 32 to 35 pounds. This indicates a total consumption of over 200 million pounds—more than double the current rate. If car use of adhesives increases in the same proportion, what a lovely market it would represent!

Constant Improvement

If you have a son or daughter in college, the chances are that you are familiar with the latest fad, namely, improving on established mottoes. Here are a few going the rounds:

"If I were you—I wouldn't admit it."

"I've always admired your get up and go—why don't you?"

"As I look into your face—I see a face that needs looking into."

"Let me call you sweetheart—the other names are unprintable."

"If kindness fails—I'll hit you."

"As Zarathustra once said, 'twas always thus."

Wedding Bells—and Belles

The New York Court of Appeals has upheld a lower court ruling that a woman who quit her job to get married is entitled to unemployment insurance—if she intends to get another job. In its ruling, the tribunal stated that "marriage ought to be treated as an illness or other event of important personal consequence to the worker." We have heard many terms applied to marriage, but *illness?*

Out of This World

According to a recent news item, the aluminum architecture of tomorrow is really going to be out of this world. A well-known designer is reported to be at work on a collapsible aluminum dome that could be shot to the moon as the last stage of a rocket. Once there, it would unfold by itself, ready for immediate occupancy.